DRAFT
Environmental Impact Statement for the Atlantic Rim Natural Gas Field Development Project

Carbon County, Wyoming

BLM

Wyoming State Office — Rawlins Field Office

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

December 2005

MISSION STATEMENT

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BLM/WY/PL-06-002+1310

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Wyoming State Office
P.O. Box 1828
Cheyenne, Wyoming 82003-1828

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In Reply Refer To:

1790 (930)
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DEC 0 5 2005

Dear Reader:

This Draft Environmental Impact Statement (DEIS) for the proposed Atlantic Rim Natural Gas Development Project (ARPA) is submitted for your review and comment. The DEIS has been prepared to analyze the potential impacts of drilling and production operations of natural gas wells and associated access roads, pipelines, and production facilities proposed by Anadarko E & P Company, LP and others including Double Eagle Petroleum and Mining Company, and Warren Resources, Inc. The project area is located entirely within Carbon County, Wyoming.

Two technical support documents have also been prepared in conjunction with the DEIS. These documents contain detailed technical information for air quality and ground water modeling. A limited number of technical support documents are available upon request. The DEIS and its technical support documents will be available for review at the Bureau of Land Management (BLM) offices listed below. All of these documents may be viewed or downloaded from the BLM website at http://www.wy.blm.gov/rfo/nepa.htm

Bureau of Land
Management
Wyoming State Office
5353 Yellowstone Road
Cheyenne, Wyoming 2009

Bureau of Land
Management
Rawlins Field Office
P.O. Box 2407
Rawlins, Wyoming 82301

The ARPA was originally scoped in 2001 as the "Atlantic Rim Coalbed Methane Project." Subsequently, the project was re-named to the "Atlantic Rim Natural Gas Development Project" in view of the proponents request to reduce the number of wells proposed and to develop a limited number of conventional gas wells. The ARPA includes 270,000 acres with surface ownership of approximately 173,672 acres Federal (64 percemt), 14,060 acres State of Wyoming (32 percent) and 82,348 acres of privately held surface (4 percent). Currently, within the ARPA there are 116 natural gas wells completed to coal formations. Wells, roads, pipelines, compressors and other facilities have been constructed in conjunction with an interim drilling plan for exploratory evaluation of resources within the area.

Four alternatives are analyzed by this DEIS. The Proposed Action proposes to develop the natural gas resource by drilling up to 2000 wells, 1800 to coal beds and 200 to other formations, for a spacing of up to 80 acres per well. In addition, supporting development including pipelines, roads, and ancillary facilities are proposed. Water produced from coalbed natural gas wells would be re-injected below the land surface.

Under the No Action alternative (Alternative A) the project as proposed would be rejected. Existing Atlantic Rim wells could continue to operate as approved and constructed. Under Alternatives B and C, the same number and types of wells, including supporting development could occur. Under Alternative B, construction activities would be concentrated into one of three zones within the ARPA at a time, focusing construction-related disturbance and impacts. Alternative C evaluates the use of special protection measures that would limit surface disturbance amounts for sensitive resources.

The BLM's preferred alternative is a combination of Alternatives B and C. Additional information acquired during public comment periods and BLM internal review may result in the selection of an alternative, or combination of alternatives to provide the best mix of operational requirements, mitigation measures, and best management practices to reduce environmental harm.

If you wish to submit comments on the DEIS, we request that you make them as specific as possible. Comments are more helpful if they include suggested changes, sources, or methodologies. Comments that contain only opinions or preferences will not receive a formal response from the BLM. However, they will be considered and included as part of the BLM decisionmaking process.

The BLM can best use your comments if they are submitted within 60 days after the Environmental Protection Agency (EPA) publishes its Notice of Availability in the Federal Register. Please submit written comments to:

David Simons, Project Lead
Bureau of Land Management
Rawlins Field Office
P.O. Box 2407
Rawlins, Wyoming 82301

You may also submit comments electronically at the following address: Atlantic_Rim_EIS_WYMail@blm.gov. Please include "Atlantic Rim Natural Gas Development Project" or "ARPA" in the subject line.

Approximately 2 weeks following the publication of the EPA's Federal Register notice the BLM will host a public meeting to receive comments on the DEIS. This meeting will be announced at least 14 calendar days in advance through public notices, media news releases, and mailings.

This DEIS was prepared pursuant to the National Environmental Policy Act and other regulations and statues to address the environmental and socio-economic impacts which could result from the project. This DEIS is not a decision document. Its purpose is to inform the public and interested Agencies of impacts associated with implementing the proponent's drilling and development proposal, to evaluate alternatives to the proposal, and to solicit comments.

Freedom of Information Act Considerations: Public comments submitted for this DEIS, including the names and street addresses of respondents, will be made available for review after the comment period closes at the Rawlins Field Office during regular business hours (8:00 a.m. to 4:30 p.m.), Monday through Friday, except holidays. Public comments will be published as part of the finals EIS. Individual respondents may request confidentiality. If you wish to withhold your address from public review or from disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your written comment. Such request will be honored to the extent allowed by law. All submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public inspection in their entirety.

A copy of the DEIS has been sent to affected Federal, State, and local government agencies, and to those persons who have indicated that they wished to receive a copy of the DEIS.

If you have questions or need additional information, please contact David Simons, Project Lead, at the Rawlins Field Office, address shown above, or by phone (307) 328-4328

Sincerely,

Robert A. Bennett

Robert A. Bennett
State Director

DRAFT ENVIRONMENTAL IMPACT STATEMENT

ATLANTIC RIM

NATURAL GAS FIELD DEVELOPMENT PROJECT

Prepared by

Bureau of Land Management
Rawlins Field Office
Rawlins, Wyoming

December, 2005

EXECUTIVE SUMMARY

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1.0 INTRODUCTION

The Bureau of Land Management is analyzing a coalbed and conventional natural gas development proposal received from Anadarko E & P Company, LP, as lead proponent for a group of companies including Warren Resources, Inc., and Double Eagle Petroleum and Mining Company (Companies). The Atlantic Rim project EIS was originally scoped in 2001 as the "Atlantic Rim Coalbed Methane Project". Subsequently, the project was re-named the "Atlantic Rim Natural Gas Development Project" in view of the proponents' request to reduce the number of wells proposed and to develop a limited number of conventional gas wells. The Atlantic Rim project area (ARPA) includes about 270,035 acres with surface ownership of approximately 173,672 acres Federal, 14,060 acres State of Wyoming, and 82,348 acres of privately held surface. Currently within the ARPA are 116 natural gas wells completed to coal formations under an exploratory interim drilling program (IDP). Wells, roads, pipelines, compressors and other facilities have also been constructed in conjunction with the IDP.

The proposed action would develop the natural gas resource by drilling up to 2,000 wells, 1,800 to coal beds and 200 to other formations, for a spacing of up to 80 acres per well. In addition, supporting development including pipelines, roads, and ancillary facilities are proposed. Produced water from coalbed natural gas wells is proposed for sub-surface re-injection. Any electrical powerlines would be buried under this proposal.

Comments received to this draft environmental impact statement will be reviewed, evaluated, and responded to within the EIS process. Revisions, changes, and corrections arising from comments to the draft EIS will be assembled and released in a subsequent Atlantic Rim final EIS, also for public review and comment. Subsequently a Record of Decision detailing the Bureau of Land Management's decision and the rationale behind it will be released to the public.

1.0.1 Purpose and Need

The purpose for the Companies' proposal is to drill for, remove and sell natural gas resources. As America's need for energy continues, natural gas has emerged as an important industrial and domestic fuel source. Development of domestic natural gas reserves reduces the country's dependence on foreign sources of energy and maintains a supply of fuel for domestic consumption, industrial production, power generation and national security.

1.0.2 Issues and Concerns

The scoping process helped the BLM focus on key issues and concerns:

- Issue 1. Increased traffic and the potential for associated impacts on existing county, state, and BLM roads.
- Issue 2. Adverse socio-economic impacts to local communities.
- Issue 3. Impacts to surface water quality and resources, including an increased rate of delivery of sedimentation and salts to the Colorado River system.
  - Issue 3a. Impacts to surface hydrology including higher overland flow in response to increased road density.

- Issue 4. Impacts to groundwater resources, including sedimentation/excess salts to the Colorado River system.
- Issue 5. Potential impacts to sensitive soils within the project area.
- Issue 6. Impacts to air quality from drill rig emissions and production activities.
- Issue 7. The ability to successfully reclaim disturbed areas, timely reclamation of disturbed areas and control of noxious weed invasions.
- Issue 8. Potential conflicts with livestock management operations in the project area, including possible impacts to range improvement projects.
- Issue 9. Potential impacts to cultural and historic values within the project area including historic trails, sites eligible for inclusion in the National Register of Historic Places, and other cultural resources.
- Issue 10. Potential impacts to wildlife habitats within the project area, including those supporting big game, greater sage-grouse, and raptors.
- Issue 11. Potential impacts to listed, or proposed for listing, threatened and endangered plant and animal species, including potential Colorado River depletions and effects on downstream listed threatened and endangered fish species.
- Issue 12. Potential impacts to sensitive plant and wildlife species such as the bluehead sucker, the roundtail chub, the flannelmouth sucker, and the Colorado cutthroat trout.
- Issue 13. Cumulative effects of drilling and development activities when combined with other ongoing and proposed developments on lands adjacent to the Atlantic Rim project area.
- Issue 14. Potential conflicts between mineral development activities and recreational opportunities.

1.1 ALTERNATIVES INCLUDING THE PROPOSED ACTION

The draft EIS considers four alternatives in detail. They are the proposed action, Alternative A - No Action; Alternative B, and Alternative C. In addition, numerous other alternatives were considered but not analyzed in detail as disclosed in Chapter 2.

1.1.1 The Proposed Action

The proposed action consists of drilling and developing approximately 2,000 new natural gas wells. Approximately 1,800 would be drilled to Mesaverde formations coals to develop coalbed natural gas (CBNG) resources. An additional 200 wells would be drilled to access conventional natural gas found in other formations, generally expected to be deeper. The 2,000 proposed, new natural gas wells would be in addition to the approximately 116 ARPA exploration wells already drilled from the interim drilling period.

Proposed well spacing is 8 wells per section (80 acre spacing) throughout the project area but may reduce to 4 wells per sections (160 acre spacing) depending on the geology and ability of the operators to release the water and pressure sufficiently recover the gas. Development and drilling would begin in 2006 within the ARPA and continue for approximately 20 years, with a life-of-project (LOP) of 30-50 years. Various drilling and production related facilities (e.g., roads, pipelines, water wells, disposal wells, compressor stations, and gas processing facilities) would also be constructed throughout the ARPA.

1.1.2 Alternative A – No Action

NEPA regulations require that EIS alternative analyses in the EIS "include the alternative of no action" (40 CFR 1502.14(d)). For this analysis, "no action" means that the BLM would reject the Proponents' proposal and "the proposed activity would not take place."

1.1.3 Alternative B

This alternative proposes the same number and spacing of wells as in the proposed action. The entire project area would be developed over the course of 20 years, however, the drilling and development would occur in three phases. The first phase to be developed over a 6 – 7 year period would be within the vicinity of the Doty Mountain, Sundog/Cow Creek, and Blue Sky PODs.

During the first phase of development approximately 925 well locations would be developed. Once completed and in production, the second phase of development is proposed to occur in the northern one-third of the project area, near and including the Jolly Roger and Red Rim PODs. The third and final phase of development would occur near and including Brown Cow and Muddy Mountain PODs. Construction and drilling would last from 6-7 years per zone and would include completion of interim reclamation. Gas production operations would begin and continue within an active zone as construction occurs. The extent of gas production facilities would continue to accumulate as time passes with ultimately the same level of operational (production) disturbance as the other action alternatives at completion. Once developed, production would continue throughout the project area.

1.1.4 Alternative C

Development for natural gas would occur as in the proposed action, but would be conditioned with the application of required development protection measures (DPM) in those areas with sensitive or crucial resource values (Appendix L) resulting in fewer acres of disturbance and reduced road density. Generally, DPMs focus on surface disturbance limits, modification of drilling and construction practices, and, in some cases, no surface occupancy. Examples of such areas are sensitive wildlife and fish habitat, and areas with sensitive soils. These types of areas are unique enough to require additional protective measures beyond what is already provided by applying Required Best Management Practices (BMPs) (Appendices H and J), lease stipulations, and Conditions of Approval (COAs) (Appendix K). As an end product, geographic information system (GIS) layers would be available to operators for development of site specific proposals for their planning of the annual program of work during the Application for Permit to Drill (APD) process.

1.2 ENVIRONMENTAL ANALYSIS

1.2.1 Geology / Minerals / Paleontology

No significant effects are anticipated for these resources under any of the action alternatives (proposed action, alternative B and alternative C). The purpose of this proposal is to remove natural gas resources which would be permanently removed.

1.2.2 Soils

For the proposed action and Alternative B many areas are expected to exceed the significance criteria for soils. Some localized areas are expected to have effects that exceed the soils significance criteria under alternative C. The revegetation potential of disturbed soils is expected to be low to moderate under all the alternatives. While no biological crusts are mapped or known to exist with the ARPA, some crusts, if they do exist, may be damaged as a result of the proposed action and alternative B. Fewer crusts are expected to be damaged or removed under alternative C.

1.2.3 Water Resources

Impacts to waterbodies with impairment or threats of impairment to the State of Wyoming's 303d list (Muddy Creek) are expected from the proposed action and alternative B. Impacts to Muddy Creek under alternative C would not likely be significant.

Salinity loading in run-off would increase above background conditions for the proposed action and alternative B. Under alternative C salt loads would be measurably higher but are not expected to be significant.

Under the proposed action and alternative B changes in hydrologic function in wetlands would occur, and indirect impacts could be significant. Direct impacts are expected to occur but not be significant. For alternative C, direct and indirect impacts are not likely to be significant. Changes in stream flow characteristics would occur under the Propose Action and indirect effects could be significant. For alternative B, changes in hydrologic function would occur but are expected to have lower impacts than under the proposed action. Indirect effects could be significant. Under alternative C impacts are not likely to be significant.

For the proposed action and alternative B changes in geomorphology due to increased surface run-off, erosion and increased sediment loads would occur in localized areas and cumulative impacts would be significant. Impacts are not likely to be significant under alternative C.

The Standard for Healthy Rangelands for water resources would continue to fail in areas due to indirect impacts and would be significant for the proposed action and alternative C. For alternative B effects are not likely to be significant.

1.2.3.1 Ground Water

Under all three of the action alternatives, effects are not expected to be significant on springs, seeps and artesian wells, although some short-term reduction in flows are expected. Ground water quality is not likely to be significantly diminished under any of the alternatives. The depth to ground water in permitted wells is not expected to be significantly impacted under any of the alternatives.

1.2.4 Range and Other Land Uses

Significant impacts from changes in animal unit months (AUMs), livestock mortality, and disturbance of livestock grazing operations and facilities are expected under the proposed action and alternative B. Under alternative B it is likely that range operators may suspend grazing operations due to the intensity of development in the active area. Under alternative C impacts are not expected to be significant due to reduced surface disturbance.

1.2.5 Vegetation

Significant effects from increased erosion from roads on moderate to steep slops and alkali sage communities prone to erosion would result in long-term loss of productivity with significant effects for the proposed action. Alternative B is expected to have similar impacts to the proposed action. Due to reduced surface disturbance under alternative C impacts are not expected to be significant.

Indirect effects from erosion and altered run-off patterns from adjacent uplands would have significant impacts for riparian communities under the proposed action and alternative B. Effects are not expected to be significant under alternative C. Long term loss of shrubs, including Wyoming and alkali sagebrush sites, are expected to have significant impacts under the proposed action and alternative B. Reduced surface disturbance and treatment of roads would result in lower impacts to vegetation and may not be significant if overall browse use rates remain at moderate levels under alternative C.

For those aspen and mountain shrub communities that have failed Rangeland Health standards, additional disturbance from development would exacerbate the failed standard, resulting in increased difficulty in meeting the Standard, and corresponding significant effects.

The potential for the spread or new infestations of weeds on disturbed sites is high to very high, although impacts would not exceed the significance criteria for alternative B and the proposed action. Reduced surface disturbance under should result in reduced spread and infestation of weeds under Alternative C

1.2.6 Wildlife

For the proposed action and alternative B impacts on shrub-dependant songbird nesting habitats would be significant. Under alternative C, impacts are not expected to be significant. Impacts to greater sage-grouse and Columbian sharp-tailed grouse would be significant under all the action alternatives.

For big game, including mule deer and elk, significant effects are expected under all the action alternatives. For antelope significant effects are expected for the proposed action and alternative B. Impacts are not expected to be significant under alternative C to antelope.

Impacts to threatened and endangered, proposed and candidate species, and other sensitive species (other than greater sage-grouse and sharp-tailed grouse) and raptors are not expected to be significant under any of the action alternatives. Impacts to threatened and endangered fishes occurring downstream of the ARPA are not expected to occur. Significant impacts to BLM sensitive fishes are expected under the proposed action and alternative B in Muddy Creek. Under alternative C significant impacts are not expected.

1.2.7 Recreation

Under all the action alternatives displacement of wildlife and the loss of a natural appearing setting would make the ARPA undesirable for hunting or wildlife viewing. These visitors would be displaced and impacts would be significant. Impacts to scenery, noise, dust and human activity would reduce the ARPA's desirability as a place to camp significantly under all the action alternatives. Effects to access, traffic, and from dust and human activity to the ARPA would be significant under all the action alternatives.

1.2.8 Visual Resources

For pleasure driving and mountain biking, impacts would be significant for the proposed action and alternative B. Impacts would not be significant under alternative C. Management objectives for VRM Class III viewsheds would be exceeded under alternative B and the proposed action. Management objectives would not be exceeded under alternative C.

1.2.9 Cultural Resources

Impacts to cultural resources as a result of construction activities could impact an estimated 126 sites under all the action alternatives. Reduced visual impacts to settings, where they contribute to site eligibility for historic trails, is expected to be less under alternative C compared to the proposed action and alternative B.

1.2.10 Socioeconomics

<u>Economic Effects</u>
Alternative C would likely result in less than 2,000 wells, depending on the specific sites proposed for development. Up to 2,000 wells could be drilled under the proposed action and alternative B. Depending on the site specific proposals that come forward drilling expenditures could be higher for individual wells under alternative C than the proposed action and alternative B based on the various development protection measures that might apply.

Direct expenditures for drilling/field development are anticipated to be $981 million, although costs could be higher depending on development protection measures for alternative C. Economic impacts from drilling/field development are expected to be $1.25 billion unless fewer wells are constructed under alternative C. For the proposed action and alternative B, 578 average annual jobs are predicted. Under alternative C, fewer jobs could occur depending on the site specific proposals for development received and any corresponding reductions in well numbers. $6.4 billion in total economic impacts related to production are expected for alternative B and the proposed action. Less revenue could be realized under alternative C if fewer wells are drilled and less gas extracted. Impacts to other economic activities within the ARPA include the potential for reductions in the grazing, recreation and hunting economies from the proposed action and alternative B. Alternative C is expected to have a reduced impact on these activities.

<u>Employment, Population and Housing</u>
Peak year drilling and production employment is predicted at 1,490 for the proposed action and alternative B. Peak year population impacts are estimated at about 1,100 and peak year housing demand at 440 units for both alternatives. For alternative C, effects could be reduced if less wells are drilled due to development protection measures.

Local Government Facility and Service Demands
Local government facility and service demands are expected to be the same for all three action alternatives. Most local government facilities have excess capacity, while some services may need to expand to accommodate growth. Revenue should be adequate to address growth and development needs, but may lag at the time of demand. Municipalities may not receive direct project related revenues in sufficient amounts of offset the costs of needed expansion in some cases.

Federal, State and Local Revenues
Specific amounts of revenue anticipated are detailed in Chapter 4. For all the various revenue sources the proposed action and alternative B are expected to have similar effects. Revenues under alternative C are expected to be less, depending on the effects of development protection measures on the number of wells drilled and gas extracted.

1.2.11 Transportation

Specifics of increased traffic levels are detailed in Chapter 4. Average annual daily travel levels would increase for Carbon County Road (CCR) 605N (20 Mile Road), CCR 608 (Wild Cow Road), CCR 501 (Cherry Grove Road), Interstate 80, WY 789 and WY 70 under the proposed action and alternative B. Increased traffic levels would be lower under alternative C depending upon the impacts of development protection measures on the number of wells drilled. Impacts to county roads would include additional maintenance costs, increased property tax revenues from production with the possibility of a lag time between the need for work and the realization of revenue.

1.2.12 Health and Safety

The risk of industrial injuries would occur under all three action alternatives. Due to the intensity of development and relative closeness of construction activities, there would be a slightly increased occupational hazard under alternative B. If less wells are drilling under alternative C, there would be a correspondingly reduced risk of hazards. The potential for hazardous material spills / exposure would be the same for the proposed action and alternative B, and somewhat reduced under alternative C.

1.2.13 Noise

For the proposed action and alternative C drilling, field development activities, workovers and other maintenance activities would temporarily exceed 55 dBA threshold at drilling and construction sites. Exposure would be limited to project workers who are protected by noise regulations and, temporarily, to other visitors to the Project area. For alternative B, noise impacts would be focused within the active zone with similar effects to the other action alternatives.

1.3 AGENCY PREFERRED ALTERNATIVE

The BLM preferred alternative in this case is a combination of alternatives B and C. Disclosure of the agency preferred alternative does not imply that this will be the BLM's final decision. Additional information acquired during public comment periods and BLM internal review comments, may result in the selection of an alternative, or combination of alternatives

to provide the best mix of operational requirements and mitigation / best management practices to reduce environmental harm.

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DRAFT EIS

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AADT	Annual Average Daily Traffic
ACED	Area of Critical Environmental Concern
ACOE	Department of Army Corps of Engineers
AEO	Annual Energy Outlook
AJE	Annual Job Equivalents
AML	appropriate management level
ANC	Acid Neutralizing Capacity
AO	Authorized Officer
APD	Application for Permit to Drill
APE	area of potential effect
AQD	Air Quality Department
AQRV	Air Quality Related Values
ARPA	Atlantic Rim Project Area
ATP	*Aretmisia tridenada* var *pauciflora*
ATT	*Artemisia tridenada ssp tridentada*
ATV	all-terrain vehicle
ATV II	*Artemisia tridentada* var *vaseyana*
ATW	*Artemisia tridentada ssp. wyominesis*
AUM	animal unit month
BA	Biological Assessment
BACT	Best Available Control Technology
bbl	barrel
BBS	Breeding Bird Survey
BCF	billion cubic feet
BMP	Best Management Practices
BLM	Bureau of Land Management
CASTNET	Clean Air Status and Trends Network
CBNG	coalbed natural gas
CCR	Carbon County Road
CCSD	Carbon County School District
CDNST	Continential Divide Scenic Trail
CEC	catio exchange capacity
CEQ	Council for Environmental Quality
CIA	Cumulative Impacts Analysis
CO	Carbon Monoxide
COE	U.S. Corps of Engineers
CR	County Road
CRBSCF	Colorado River Basin Salinity Control Forum
CREG	Consensus Revenue Estimating Group
CSU	controlled surface use
CWA	Clean Water Act
CWIN	Crucial Winter
CWRRI	Colorado Water Resource Research Institute
CWYL	crucial winter/yearlong
DAT	deposition analysis thresholds
dBA	decibel
DEIS	Draft Environmental Impact Statement
dv	deciview
DEQ	Department of Environmental Quality
DRG-E	Enhanced Digital Raster Graphics

EA	Environmental Assessment
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EMT	emergency medical technician
EO	Executive order
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973
ESP	exchangeable sodium percentage
FY	fiscal year
FWS	U.S. Fish and Wildlife Service
GAP	Gap Analysis Project
GDRA	Great Divide Resource Area
GIS	geographical information system
GLEES	Glacier Lakes Ecosystem Experiment Site
gpm	gallons per minute
GWA II	Greater Wamsutter Area II
HAP	Hazardous Air Pollutants
HMA	Herd Management Areas
HWA	Hayden-Wing Associates
HUC	Hydrologic Unit Code
I-80	Interstate 80
ID	interdisciplinary
IDT	interdisciplinary team
IMPLAN	impact analysis for planning
IMPROVE	Interagency Monitoring of PROtected Visual Environments
JTU	Jackson turbidity units
KMDA	known mineral deposit area
LAC	Levels of Acceptable Change
LOC	levels of concern
LOP	Life of Project
LOS	level of service
LSRCD	Little Snake River Conservation District
LSRV	Little Snake River Valley
MEI	Maximally Exposed Individual
mi^2	square mile
MLE	Most likely Exposure
MODFLOW	Three Dimensional Finite Difference Modular Groundwater Flow Model
MSDS	Material Safety Data Sheet
NAAQS	National Ambient Air Quality Standards
NAPD	National Acid Deposition Program
NPA	national programmatic agreement
NED	National Elevation Dataset
NEPA	National Environmental Policy Act
NESC	National Electric Safety Code
NGPC	Nebraska Game & Parks Commission
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NOIA	notice of intent to abandon
NPC	National Petroleum Council
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places

NSI	no significant impacts
NSR	new source review
NTN	National Trends Network
NWI	National Wetland Inventory
O_3	Ozone
OHV	off-highway vehicles
ORV	off road vehicles
OSD	Official Soil Series Descriptions
OSHA	Occupational Safety and Health Administration
P & A	plugged & abandoned
POD	Plan of Development
PP & L	Pacific Power and Light
ppm	parts per million
PM_{10}	Particulate Matter less than 10 microns
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PRBP	Powder River Basin Oil & Gas Development Project
PSD	Prevention of Significant Deterioration
psi	pound per square inch
RCRA	Resource Conservation and Recovery Act
RFD	reasonably foreseeable development
RFFA	reasonably foreseeable future acitivies
RFO	Rawlins Field Office
RMP	Resource Management Plan
RO	reverse osmosis
ROD	Record of Decision
ROW	Right-of-Way
RPM II	Reactive Plume Model
RUSLE	Revised Unified Soil Loss Equation
RV	recreational vehicle
SAR	sodium absorption ratios
SARA	Superfund Amendments and Reauthorization
SCS	Soil Conservation Service
SEO	State Engineers Office
SERCD	Saratoga-Encampment-Rawlins Conservation District
SH	Wyoming State Highway
SHPO	State Historic Preservation Office
SI	significant impact
SO_2	Sulfur Dioxide
SPCC	Spill Prevention Control and Countermeasures
SRMA	Special Resources Management Area
SSF	spring/summer/fall
SVR	Standard Visual Range
SWPPP	Storm Water Pollution Prevention Plan
T & E	Threatened and Endangered
TCF	trillion cubic feet
TDS	total dissolved solids
TP	transportation plan
TPQ	threshold planning quality
TRC	Texas Resource Consutlants
TSS	total suspended solids
T.U.	Tritium Unit
$\mu g/m^3$	micrograms per cubic meter

UGMA	Upland Game Management Area
UCG	in-situ coal gasification
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USDL	United State Department of Labor
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish & Wildlife Service
USGS	United State Geological Survey
USLE	Universal soil loss equation
VOC	volatile organic compounds
VRM	Visual Resource Management
WAAQS	Wyoming Ambient Air Quality Standards
WAS	Western Archaeological Services
WDAI	Wyoming Department of Administration and Information
WDEA	Wyoming Division of Economic Analysis
WDEQ	Wyoming Department of Environmental Quality
WGFD	Wyoming Game and Fish Department
WGISC	Wyoming Geographical Information Science Center
WH	Wyoming Highway
WOGCC	Wyoming Oil and Gas Conservation Commission
WOS	Wildlife Observation System
WRCC	Western Regional Climate Center
WRDS	Water Resource Data Center
WSP	Statewide protocol
WYDOT	Wyoming Department of Transportation
WYGISC	University of Wyoming Geographical Information Science Center
WYL	winter/yearlong
WYNDD	Wyoming Natural Diversity Database
WYO 789	Wyoming State H

CHAPTER 1

PURPOSE AND NEED

CHAPTER 1

PURPOSE AND NEED

1.0 INTRODUCTION

The Atlantic Rim Natural Gas Project (ARPA) began in 2000 with a 96 coal bed natural gas (CBNG) well proposal submitted by Stone & Wolf. A scoping notice describing the 96 well project was mailed out to the public on February 25, 2000. During the preparation of the environmental assessment for its CBNG exploration program, Stone & Wolf sold its operating rights to Petroleum Development Corporation (PEDCO) and Warren Resources Incorporated (WRES). In addition to the Stone & Wolf properties, PEDCO / WRES had also acquired additional lease holdings on private and federal lands located north of the Stone & Wolf proposal. PEDCO / WRES notified BLM on May 3, 2001, they wished to withdraw their application for the 96 well project.

In June of 2001, the Atlantic Rim operators submitted to the BLM, Rawlins Field Office (RFO), that they proposed to explore and develop coalbed natural gas (CBNG) resources located within the administrative boundary of the BLM's RFO in Townships 13 through 20 North, and Ranges 89 through 92 West, Carbon County, Wyoming. Upon review of the new proposal, the BLM determined the increase in CBNG well numbers and the level of development activity could potentially result in significant impacts and that an environmental impact statement (EIS) would be necessary.

The newly proposed Atlantic Rim CBNG project was scoped commencing on June 14, 2001. The project area encompasses approximately 270,080 acres, of which 173,672 (64.3%) acres are federal surface, 14,060 acres (05.2%) are State of Wyoming lands, and 82,348 acres (30.5%) are private or fee surface. In the scoped proposal in 2001, PEDCO and the other operators proposed a maximum of 3,880 CBNG wells to be drilled in the ARPA area. The number of wells was calculated by estimating 8 wells / section (80 acre) spacing throughout the entire ARPA (Appendix M: 2001 Project Area). Drilling was projected to last for approximately 6-10 years, with a life-of-project (LOP) of 20-30 years. In December 2002, WRES entered into a partnership with Anadarko Petroleum Corporation (APC) for the exploration and potential development of the ARPA. At that time, APC became the lead proponent of the ARPA EIS document.

<u>Interim Exploration Drilling Program (IEDP)</u>

In 2001 to obtain additional data and to allow for interim drilling concurrent with the preparation of the DEIS, an Interim Exploration Drilling Program (IEDP) was developed by the RFO in conjunction with the BLM's Reservoir Management Group (RMG) describing the criteria for which interim drilling would be allowed (see Appendix A, Interim Drilling Policy). A maximum of 200 exploration CBNG wells in nine Plan of Development (POD) locations would be allowed and a maximum of 24 CBNG wells drilled within any one POD (Appendix M: 2001 Project Area). Individual PODs were subsequently analyzed by the BLM through NEPA for effects and significance and separate decisions made for each POD (Table 1-1). Currently only six of the nine PODs have been analyzed with an environmental assessment, FONSI and Decision Record issued for each. The operators have not submitted proposals to the BLM for the 3 remaining PODs.

Table 1-1. Current POD Status and General Location.

EA/Pod Name	Date of Decision Record	General Location
Pod #1 No Name	No proposal submitted	T20N-R89W
Red Rim	04-30-04	T20N-R89W
Jolly Roger Alpha	12-14-04	T18 &19N-R90W
Jolly Roger Beta	No proposal submitted	T18 &19N-R90W
Doty Mountain	02-06-04	T17N-R91W
Blue Sky	7-26-02	T15N-R91W
Sun Dog/Cow Creek	12/21/01 & 6-26-02	T16N-R90 & 91W
Brown Cow	12-12-03 Phase I	T14N-R90 & 91W
Muddy Mountain	No proposal submitted	T14N-R90W

The primary objective of the exploratory drilling was to drill, complete, and produce CBNG wells to determine:

- gas content and productivity of the coals,
- what density of wells is needed to effectively dewater coal formations and produce natural gas,
- if produced water can be effectively disposed of through re-injection,
- which drilling and completion techniques are economical,
- water quality, connectivity to surface waters, and
- and to what depths or pressure windows may be preferred to target economic gas production.

1.1 PROJECT DESCRIPTION AND LOCATION

1.1.1 Description

Anadarko Petroleum Corporation of Houston, Texas, has submitted to the Bureau of Land Management (BLM), Rawlins Field Office, that they and other operators (including Double Eagle Petroleum and Mining Company, and Warren Resources, Inc.), hereafter referred to as "the Operators"), a proposal to explore and develop coalbed natural gas (CBNG) resources located within the administrative boundary of the BLM's Rawlins Field Office. The Operators have proposed to drill, complete, and operate approximately 2,000 new natural gas producing wells, of which 1,800 wells would be CBNG production from Mesaverde coals and 200 wells would be production from deeper conventional formations. Drilling is expected to occur over approximately 20 years, with an estimated life-of-project (LOP) of 30-50 years.

During preparation of this environmental impact statement (EIS) exploratory drilling on an interim basis has taken place with the approval of the BLM within the Atlantic Rim Project Area (ARPA). The Operators needed to conduct exploratory drilling to define the gas resource and collect information used in the preparation of this EIS. Table 1-4 describes interim drilling pods and well status.

1.1.2 Location

The ARPA is located within the administrative boundary of the BLM's Rawlins Field Office. The proposed ARPA is generally located in Townships 13 through 20 North, and Ranges 89 through 92 West, Carbon County, Wyoming, as shown in Appendix M: Project Area Map and 2005 Proposed Action Project Area. The total project area encompasses approximately 270,080 acres, of which 173,672 acres are federal surface; 14,060 acres are State of Wyoming lands; and 82,348 acres are private surface (Table 1-1; Appendix M: Ownership).

Table 1-2. Surface Ownership of the ARPA.

	Area/Acres	%
Federal	173,672	64.3
State	14,060	5.2
Fee	82,348	30.5
Total	**270,080**	**100.0**

Surface ownership does not always correspond to mineral ownership. As detailed in Tables 1-2 and 1-3 the Federal government manages more mineral estate than surface estate. The BLM does not control or authorize mineral development on private or state lands except for those areas where BLM owns the mineral rights. In those cases where private or state land developments impact BLM through actions such as access across federally managed lands the BLM must analyze those proposals under NEPA prior to approving such actions.

Table 1-3 Mineral Ownership within the ARPA.

	Area/Acres	%
Federal	179,438	66.4
State	12,384	04.6
Private	78,258	29.0
Total	**270,080**	**100.0**

Table 1-4. Interim Pods and Status within the ARPA.

Pod #	Name	Acres	Wells				Project Status
			Gas	Injection	Monitor	Total	
1	Not Planned	-x-x-	0				Dropped by Proponent
2	Red Rim	Pending	16	2		18	Approved 4/30/04
3	Jolly Roger Beta	-x-x-	0				Not Proposed to Date
4	Jolly Roger	5,120	26	2	1	29*	Approved 12/14/04
5	Doty Mtn.	1,920	24	2		26	Completed
6	Cow Creek	2,050	14	1	1	16	Completed
6	Sun Dog	1,000	10	1		11	Completed
7	Blue Sky	1,921	23	2	1	25	In-fill Drilling in Progress
8	Brown Cow	800	24	2		26	Completion Expected Fall 2005
9	Muddy Mtn						On Hold—Environmental Concerns

*number may drop

1.2 PURPOSE OF AND NEED FOR ACTION

1.2.1 Purpose and Need for the Proposed Development

Exploration and development of federal oil and gas leases by private industry are an integral part of the BLM's oil and gas leasing program under authority of the Mineral Leasing Act (MLA) of 1920 as amended, the Mining and Minerals Policy Act of 1970, the Federal Land Policy and Management Act of 1976 (FLPMA), the National Materials and Minerals Policy, Research and Development Act of 1980, and the Federal Onshore Oil and Gas Leasing Reform Act of 1987.

The BLM oil and gas leasing program encourages development of domestic oil and gas reserves. Natural gas (including coalbed natural gas) is an integral part of the United States' energy future due to its availability and the presence of the existing market delivery infrastructure. By developing domestic reserves of clean burning natural gas, the U.S. would reduce dependence on foreign energy, such as natural gas from Mexico and Canada. The environmental advantages of burning natural gas rather than oil or coal were emphasized by the U.S. Congress and by the President when the Clean Air Act Amendments of 1990 were signed into law. In addition, the Energy Policy acts of 2001 and 2005 emphasize the development of domestic natural gas reserves for supply and economic stability.

To meet this growing demand, the National Petroleum Council projects that U.S. domestic gas production will increase from the 2002 level of 18 trillion cubic feet (TCF) to 21 TCF in 2025. The remaining demand will be met by imports of foreign natural gas, primarily from Canada. A portion of the increase in domestic supply is projected to be met by growth in production from nonconventional sources, including coalbed natural gas, from the Rocky Mountain region. Nonconventional production in the Rocky Mountain region (including Wyoming) is projected to increase by 0.7 TCF, from the 2000 level of 3.1 TCF to 3.8 TCF in 2020 (EIA 2001). In addition, the Report of the National Energy Policy Development Group states that 90 percent of electric power generation capacity additions between 1999 and 2020 are projected to be natural gas fueled. The quantity of natural gas consumed for power generation is expected to triple from 1999 to 2020 (NEP 2001). Production from the proposed Atlantic Rim Natural Gas Project could help meet this demand.

The purpose of, and need for, the proposed natural gas development is to exercise the lease holders' rights within the project area to drill for, extract, remove, and market gas products. Also included is the right of the lease holders within the project area to build and maintain necessary improvements, subject to renewal or extension of the lease or leases in accordance with the appropriate authority.

1.3 RELATIONSHIP TO POLICIES, PLANS, AND PROGRAMS

1.3.1 Conformance with the Great Divide Resource Area Management Plan EIS and Record of Decision

The document which directs management of the federal lands within the project area is the Record of Decision (ROD) and Approved Resource Management Plan (RMP) for the Great Divide Resource Area (USDI-BLM 1987, 1988, 1990). The BLM's Great Divide Resource Area RMP (USDI-BLM 1990) reviewed all public lands in the resource area and determined them to be suitable for oil and gas leasing and development, subject to certain stipulations. The proposed project is in conformance with management objectives and actions provided for in the

ROD and RMP as detailed on pages 30 – 32 of that document. The Great Divide RMP is currently undergoing revision as the Rawlins Resource Management Plan.

1.3.1.1 Management Objectives

Management objectives applicable to the proposed action and include:

- To provide opportunity for leasing, exploration, and development of oil and gas while protecting other resource values.

1.3.1.2 Management Actions

Management actions applicable to the proposed action and alternatives include:

- The RMP states that the entire planning area is open to oil and gas leasing, subject to restrictions needed to protect resources. This action is in conformance with the Great Divide RMP.

1.3.2 Relationship to Other Plans and Documents

Other environmental analyses and plans completed or planned for completion in the immediate vicinity of the Atlantic Rim project area (Appendix M: Mineral Development Projects in the Vicinity) include the following documents:

- Little Snake River Conservation District (LSRCD) Watershed Management Plan.

  The Proposed Action would be located within the LSRCD and pay ad valorem taxes to the district. The LSRCD is a subdivision of the State of Wyoming that receives its statutory authority from Title 11, Chapter 16 of the Wyoming Statutes. Statutory authorities and responsibilities of conservation districts include the development of comprehensive plans for range improvement and stabilization, soil and water conservation and flood control and the development of ordinances, rules and regulations to implement conservation plans. Conservation is defined as:
  "... development, improvement, maintenance, preservation, protection and use of natural resources, and the control and prevention of flood water and sediment damages, and the disposal of excess waters" (WS 11-16-102 (iv)).

- Desolation Flats Natural Gas Field Development Project Environmental Impact Statement and Record of Decision (July, 2004). This natural gas development project area is generally located in Townships 13 through 16 North and Ranges 93 through 96 West in Carbon and Sweetwater counties. The total project area includes approximately 233,542 acres.

  This EIS provides analysis of potential environmental impacts in the Desolation Flats project area, with development activities beginning in 2004 and surface disturbing activities continuing for 20 years. Natural gas production is estimated to span 30 to 50 years. Approved project components include 385 wells located on 361 locations with associated roads, pipelines, and ancillary facilities. Total new project related short-term disturbance is estimated at 4,923 acres. The ROD and EIS are available on the internet at http://www.wy.blm.gov/nepa/rfodocs/desflats/desolationflats.htm.

- Continental Divide/Wamsutter II Natural Gas Development Environmental Impact Statement and Record of Decision. This natural gas development project includes the Continental Divide area combined with the Greater Wamsutter Area II and is referred to as the Continental Divide/Wamsutter II Project Area. The combined project area is generally located in Townships 15 through 23 North, Ranges 91 through 99 West, in Sweetwater and Carbon Counties, Wyoming. The total combined area encompasses approximately 1,061,200 acres.

  This EIS provides an assessment of environmental impacts associated with development of natural gas resources in the Continental Divide/Wamsutter II natural gas producing area. The project entails the development of natural gas resources beginning in 1999 and continuing for approximately 20 years, with a project life of 30 to 50 years. Well defined predictions on the total number of wells and timing of drilling operations are not currently available due to the lack of natural gas exploration in much of the project area. The BLM and Continental Divide/Wamsutter II Operators estimate that up to 3,000 well locations may be developed on federal and private lands within the project area. Various associated facilities (e.g., roads, pipelines, power lines, water wells, disposal wells, evaporation ponds, compressor stations, etc.) would also be constructed. The Record of Decision is available for review on the internet at http://www.wy.blm.gov/nepa/rfodocs/CDWRODEIS.pdf.

- Creston/Blue Gap Natural Gas Project Environmental Impact Statement (USDI-BLM 1994). This EIS was approved on October 4, 1994, and provided an assessment of the environmental consequences of a proposed natural gas development located west of the Atlantic Rim area. The BLM's decision allowed a maximum of 275 wells on 250 locations on a 160-acre spacing pattern. Impacts associated with this proposed development will be included in the cumulative impacts analysis in the Atlantic Rim EIS.

- South Baggs Area Natural Gas Development Project Environmental Impact Statement (USDI-BLM 1999, 2000). This EIS was approved on August 8, 2000, and provided an analysis of the environmental consequences of a proposed natural gas development located south of the Atlantic Rim area. The BLM's decision allowed a maximum of 50 wells on 50 locations on a 160-acre spacing pattern. Impacts associated with this proposed development will be included in the cumulative impacts analysis in the Atlantic Rim EIS.

1.4 AUTHORIZATIONS AND PERMITS

The proposed federal, state, county, and local authorizations and permits required to implement the ARPA natural gas development project are listed in Table 1-5.

Table 1-5. Federal, State, and County Authorizing Actions.

AGENCY	NATURE OF ACTION
DEPARTMENT OF INTERIOR	
Bureau of Land Management (Rawlins Field Office)	Approves Applications for Permit to Drill (APDs), Sundry Notices and Reports on Wells (sundry notices), production facilities, disposal of produced water, gas venting or flaring, and well plugging and abandonment for federal wells. Grant ROWs to Operators for gas field development actions on BLM surface outside of federal lease or unit boundaries and to third party applicants (i.e., non-unit operator or non-lease holder) both within and outside of the unit boundary. Reviews inventories of, and impacts to cultural resources affected by undertakings, and consult with SHPO and ACHP as required by the Wyoming State Protocol. Review impacts on federally listed or proposed for listing threatened or endangered species of fish, wildlife, and plants, and consult with U.S. Fish and Wildlife Service.
(Casper District - Reservoir Management Group)	Grants Unit Area Agreement and subsequent actions relative to the unit. Administers drainage protection and protection of correlative rights on federal mineral estate.
U.S. Fish and Wildlife Service	Reviews impacts on federally listed, or proposed for listing, threatened or endangered species of fish, wildlife, and plants. Migratory bird impact coordination.

DEPARTMENT OF THE ARMY	
U.S. Army Corps of Engineers	Issues (Section 404) permit(s) for placement of dredged or fill material in, or excavation of, waters of the U.S. and their adjacent wetlands.
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY	
Water Quality Division	National Pollution Discharge Elimination System (NPDES) permits for discharging waste water and storm water runoff. Conformance with all surface water standards; permit to construct and permit to operate. Permits to construct settling ponds and waste water systems, including ground water injection and disposal wells. Regulate disposal of drilling fluids from abandoned reserve pits. Administrative approval for discharge of hydrostatic test water.
Air Quality Division	New Source Review (NSR) Permit: All pollution emission sources, including compressor engines and portable diesel and gas generators.
WYOMING STATE ENGINEER'S OFFICE	
	Issues permits to appropriate groundwater and surface water. Issues temporary water rights for construction permits to appropriate surface water.

WYOMING STATE HISTORIC PRESERVATION OFFICE	
	Provides consultation concerning inventory of, and impacts to, cultural resources.
CARBON COUNTY	
	Grants small wastewater system permits, where applicable. Issues driveway access permits where new roads intersect with county roads. Prepares road use agreements and/or oversize trip permits when traffic on county road exceeds established size and weight limits or where the potential for excessive road damage exists. Issues construction and conditional use permits for all new structures. Administers zoning changes where applicable. Control of noxious weeds. Permits to bore or trench county roads or for any crossing or access off a county road.

WYOMING OIL AND GAS COMMISSION	
	Acts as primary authority for drilling on state and privately held mineral resources, and secondary authority for drilling on federal lands. Holds authority to allow or prohibit flaring or venting of gas on private or state owned minerals. Regulates drilling and plugging of wells on private or state owned minerals. Issues Aquifer Exemption Permit. Approves directional drilling. Administers rules and regulations governing drilling units. Water injection well permits Grants gas injection well permits. Administers drainage protection and protection of correlative rights on private/state mineral estate.

1.5 PUBLIC PARTICIPATION

The Atlantic Rim Coal Bed Natural Gas scoping period commenced in June, 2001 and ended on July 25, 2001. Among those contacted were State and Federal agencies, State and local elected representatives, municipalities, Native American Tribes, grazing permittees, Lease and right-of-way holders, landowners within the ARPA, local media, and other agencies, industry representatives, individuals, and organizations. 57 comments in the form of letters, e-mails, and faxes were received from the public including citizens, interested federal, state, and local agencies, advocacy groups and various corporations. These comments were used in determining key issues, resource conflicts and concerns, alternatives and the scope of the analysis.

1.6 ISSUES AND CONCERNS

Key Issues:

- Issue 1. Increased traffic and the potential for associated impacts on existing county, state, and BLM roads.

Increased traffic on existing county, state and BLM roads can result in increased traffic hazards, higher maintenance costs, the need to upgrade roads and more intensive transportation planning.

- Issue 2. Adverse socio-economic impacts to local communities.

Impacts to local communities including demand for housing that might exceed local capabilities, demand for local services such as medical, retail and civic services beyond the capacity of the community to deliver, and the need to expand local government services and presence without corresponding revenue / compensation from increased development.

- Issue 3. Impacts to surface water resources, including an increased rate of delivery of sedimentation and salts to the Colorado River system.

  - Issue 3a. Impacts to surface water quality include increases in sediment and salt delivery to the Colorado River system.

Concerns relating to the production of large amounts of water from coal formations with corresponding discharges into the Colorado River system would effect water quality and affect local and non-local government agreements were expressed by commentors and the interdisciplinary team. Additional concerns relating to changes in water quality and the presence of sensitive fish species within Muddy Creek were expressed. Increased erosion associated with continuous surface water discharges into ephemeral and intermittent stream courses was expressed as a concern.

  - Issue 3b. Impacts to surface hydrology including higher overland flow in response to increased road density.

Higher overland flows can increase erosion and correspondingly increase salt and sediment delivery within the Colorado River system and decrease water quality.

- Issue 4. Impacts to groundwater resources, including sedimentation/excess salts to the Colorado River system.

Impacts to groundwater include potential changes in groundwater aquifers due to the reduction of hydrostatic pressure in the coal seams and re-injection. Local wells, springs, and seeps provide water for livestock, wildlife, and unique vegetation communities within the ARPA. Decreasing or eliminating water flow can have a serious adverse effect on habitats and dependent populations of plants and wildlife.

- Issue 5. Potential impacts to sensitive soils within the project area.

Comments identified the need to provide for the maintenance and preservation of sensitive soils within the project area, including soils with difficult reclamation potential. Soils with high run-off potential, and soils with excess salt are examples.

- Issue 6. Impacts to air quality from drill rig emissions and production activities.

Several respondents indicated that regional haze and increased dust and emissions levels were a concern, particularly within Class I airsheds associated with wilderness areas nearby. Additional concern regarding reduced air quality from construction of gas production operations were also brought forward from commentors, air quality stakeholders, and the Interdisciplinary (ID) Team.

- Issue 7. The ability to successful reclaim disturbed areas, timely reclamation of disturbed areas and control of noxious weed invasions.

The need to assure successful reclamation including immediate soil stabilization, interim reclamation within the first growing season, weed control, and monitoring of reclamation success with adaptive management in difficult areas was expressed.

- Issue 8. Potential conflicts with livestock management operations in the project area, including possible impacts to range improvement projects.

Concerns over conflicts with livestock management operations were identified by commentors. These include reduced forage availability, livestock disturbance and harassment, reduction of the viability of range improvement projects and compromised range / vegetation quality

- Issue 9. Potential impacts to cultural and historic values within the project area including historic trails, sites eligible for inclusion in the National Register of Historic Places, and other cultural resources.

The presence of Historic Trails and the resulting risk of the compromise or reduction in their contribution to the historic setting within the area was expressed by commentors and the ID Team.

- Issue 10. Potential impacts to wildlife habitats within the project area, including those supporting big game, greater sage-grouse, and raptors.

The risk of reductions in wildlife habitats and populations from the ARPA was brought forward by respondents and identified as a key concern. The need to protect and maintain crucial winter range for big game, critical winter habitat and nesting / brood rearing habitats and for sage-grouse was expressed. The need for maintenance and viability of leks for sage-grouse was identified along with the need to maintain raptor populations including timing and disturbance restrictions. In addition, the need for further information on big game migration corridors and for their maintenance as viable routes for big game was identified.

- Issue 11. Potential impacts to listed, or proposed for listing, threatened and endangered plant and animal species, including potential Colorado River depletions and effects on downstream listed threatened and endangered fish species.

The need to avoid adverse impacts upon threatened, endangered and sensitive species within the ARPA including maintenance of critical habitats and compliance with the Endangered Species Act was expressed.

- Issue 12. Potential impacts to sensitive plant and wildlife species including bluehead sucker, roundtail chub, and flannelmouth sucker. The presence of supporting habitat for sensitive fish species within Muddy Creek, and the need to preserve and / or improve supporting habitats including water flows and quality was expressed by respondents.

- Issue 13. Cumulative effects of drilling and development activities when combined with other ongoing and proposed developments on lands adjacent to the Atlantic Rim project area.

The cumulative effects of oil and gas development within the Rawlins Field Office, the Red Desert, and the Greater Green River Basin were identified by respondents as issues.

- Issue 14. Potential conflicts between mineral development activities and recreational opportunities.

The presence of local, regional and nationally important big game populations, the corresponding traditional land use of the areas for recreation including hunting and wildlife viewing was identified. Visual conflicts with oil and gas development with these uses was identified by respondents and the ID Team. Concerns relating to the risk of decreased recreational opportunity due to impacts to big game and other wildlife populations was expressed by respondents.

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

It is important for the reader to note that BLM is authorized to approve actions on BLM managed lands and federal minerals, however, analysis of the impacts to the human environment include effects upon all land ownership types.

Any authorizations for the Atlantic Rim Natural Gas Project must comply with the applicable Resource Management Plan (RMP). The applicable RMP at this time is the Great Divide Resource Management Plan. Currently the Rawlins Field Office is revising its RMP, and to date has issued a draft Environmental Impact Statement in support of the RMP revision. When the Rawlins RMP is approved the ARPA must and would comply fully with that plan.

2.0 ALTERNATIVE DEVELOPMENT

Based on issues, concerns, and opportunities identified from public scoping comments, interdisciplinary interaction between resource professionals, and collaboration with cooperating and interested agencies, the BLM identified a range of alternatives.

2.1 ALTERNATIVES

While numerous alternatives and specific actions were considered, four alternatives are studied in detail: proposed action, no action, and two additional "action" alternatives. Alternatives and specific actions considered and eliminated from detailed study are discussed in section 2.5 of this Chapter.

2.2 ALTERNATIVE DESCRIPTION

2.2.1 The Proposed Action

The Operators have submitted the following:

- The proposed action consists of drilling and developing approximately 2,000 new natural gas wells. Approximately 1,800 would be drilled to Mesaverde formations coals to develop CBNG resources. An additional 200 wells would be drilled to access conventional natural gas found in other formations, generally expected to be in deeper formations.

- The 2,000 proposed, new natural gas wells would be in addition to the approximately 116 ARPA exploration wells from the interim drilling period.

- Proposed well spacing is 8 wells per section (80 acre spacing) throughout the project area and may be reduced to 4 wells per sections (160 acre spacing) depending on the geology and ability of the operators to release the water and pressure sufficiently to release and recover the gas.

- Development and drilling would begin in 2006 within the ARPA and continue for

approximately 20 years, with a life-of-project (LOP) of 30-50 years. Various drilling and production related facilities (e.g., roads, pipelines, water wells, disposal wells,

compressor stations, and gas processing facilities) would also be constructed throughout the ARPA.

- Under the proposed action, there would be approximately 4,500 acres of new short term (initial, <3 years) surface disturbance from well pads; 1,000 miles (approximately 9,850 acres) of new roads, upgrades of existing roads; and pipeline construction, and 1,480 acres of ancillary facilities. The total new short-term (initial) disturbance resulting from the proposed action would be about 15,800 acres.

- Long term (LOP) disturbance following interim reclamation anticipated for the proposed action includes approximately 2,320 acres for wells pads, 3,636 acres for roads and utilities, and 285 acres for ancillary facilities for a total of 6,241 acres LOP disturbance. Interim reclamation would reduce the total acres of disturbance by about 9,500 acres.

- Produced water from individual wells would be gathered and routed to centralized water handling and storage sites, which would serve as central injection facilities (Figure 2-1). Produced water would be disposed of through re-injection, with two exceptions. One exception being the closed system with limited use of livestock and wildlife watering systems, with appropriate State permits. The second exception would be offsets for current artesian water sources. The proponents anticipate that water produced from the 2,000 wells, if being dewatered simultaneously, would need approximately 166 injection wells for disposal.

2.2.2 Alternative A – No Action

NEPA regulations require that EIS alternative analyses in the EIS "include the alternative of no action" (40 CFR 1502.14(d)). For this analysis, "no action" means that the BLM would reject the Proponents' proposal and "the proposed activity would not take place."

2.2.3 Alternative B

This alternative proposes the same number and spacing of wells as in the proposed action. The entire project area would be developed over the course of 20 years, however, the drilling and development would occur in three phases. The first phase to be developed over 6 – 7 years would be within the vicinity of the Doty Mountain, Sundog/Cow Creek, and Blue Sky PODs.

During the first phase of development approximately 925 well locations would be developed. Once completed and in production the second phase of development is proposed to occur in the northern third of the project area, near and including the Jolly Roger and Red Rim PODs. The third and final phase of development would occur near and including Brown Cow and Muddy Mountain PODs (Alternative M: Alternative B Map - Phases of Drilling and Drilling PODs). Under this alternative previously authorized exploration and drilling activities would continue as described in the following EAs:

Sun Dog POD
Red Rim POD
Doty Mountain POD
Cow Creek POD
Jolly Roger POD
Blue Sky POD
Brown Cow POD

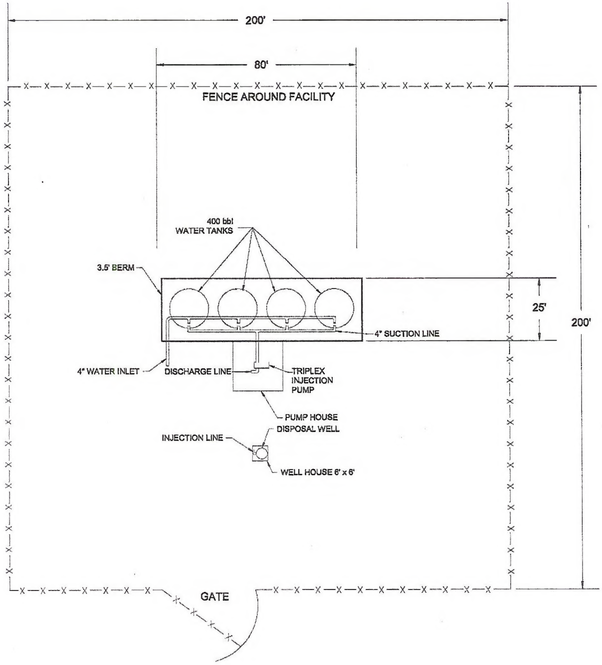


Figure 2-1. Typical Water Conditioning and Disposal Facility.

POD boundaries would remain the same as they exist and were originally proposed. No additional development would occur outside the POD boundaries in inactive zones. BLM would authorize suspensions of operations and production for all leases within the no-activity areas except for where existing oil and gas development has already occurred. Proposals to develop leases within non-active zones would be denied until the zone in which it is located becomes active for development under the Atlantic Rim ROD. For those leases suspended by the BLM no lease rental fees would accrue and the lease term would be tolled during the period the zone remained in a "no activity" status. Active status would last from 6-7 years per zone and would include completion of interim reclamation.

Gas production operations would begin and continue within an active zone as construction occurs. The extent of gas production facilities would continue to accumulate as time passes with ultimately the same level of operational (production) disturbance as the other action alternatives at completion. Once developed, production would continue throughout the project area.

2.2.4 Alternative

Development for natural gas would occur as in the proposed action, but would be conditioned with the application of required development protection measures in those areas with sensitive or crucial resource values (Appendix L). Generally, constraints would focus on surface disturbance limits, limited operating periods, modification of drilling and construction practices, and, in some cases, no surface occupancy. Resource data, in the form of GIS layers, would be used to identify specific areas of resource concern. Examples of such areas are sensitive wildlife and fish habitat, and areas with sensitive soils. These types of areas are unique enough to require additional protective measures beyond what is already provided by applying Required Best Management Practices (BMPs) (Appendices H and J), lease stipulations, and Conditions of Approval (COAs) (Appendix K). As an end product, geographic information system (GIS) layers would be available to operators for development of site specific proposals for their planning of the annual program of work during the Application for Permit to Drill (APD) process.

Below is a summary of development protection measures that would be implemented in some locations based on the presence of resources. The detailed descriptions of protection measures are in Appendix L, including references to maps (Appendix M) showing areas where the measure would apply if applicable.

- **Water and Soil Management:** No pad, compressor or water transfer sites would be located in areas with predominately steep slopes, close to perennial waters or wetlands. Interim reclamation would be completed within one year of the spud date in areas with soils with excess salts and poor top soils, since these areas are more difficult to reclaim. Low impact road design would be implemented in soils with excess salts, high runoff potential, and severe road rating to reduce impacts from roads. This should reduce salt and sediment loading in the Colorado River Basin, of concern since the 1930s. Specifications for road construction and annual maintenance to reduce dust would be implemented in areas with soils with excess salts, and in areas with a severe road rating, since these areas would generally have a higher clay or salt content in the soils and hence be more prone to dust problems. Special measures would be implemented in areas with high runoff potential to reduce surface water concentration, increase infiltration, reclamation success, and effective precipitation. Areas with high runoff potential would also have reduced surface disturbance (less than 20 acres and 4 locations per section).

- **Vegetation Resources:** In vegetation communities that would be difficult to reclaim and are in country with greater than 8% slopes, surface disturbance would be limited to less than 20 acres and 4 locations per section. In vegetation communities with high wildlife values or rare vegetation communities, no surface disturbance would be allowed (roughly 0.6% or 1,500 acres). Silver sagebrush/bitterbrush communities would have limited surface disturbance. All these communities within crucial winter range failed the Standards assessment for the Upper Colorado River Basin (BLM, 2002c). These areas would continue to fail standards without additional development protection measures.

- **Range Resources:** To protect range resources, operators shall abide by speed limits and erect signs warning drivers of livestock concentration areas such as lambing grounds and shipping pastures. Annual planning efforts would provide data to allow planning specific to pastures or allotment boundaries to facilitate livestock planning. Construction specifications will be put in place to reduce dust.

- **Wildlife Resource Management :** In grouse brood rearing or nesting habitat and big game crucial winter range, surface disturbance would be limited (less than 20 acres, 4 locations per section, and roads would be limited to <3 miles/mi^2), based on programmatic standards recommended by the Wyoming Game and Fish Department. No surface disturbance would be allowed in severe winter relief habitats for greater sage-grouse; these areas are refuges, small patches of high sagebrush that generally will not drift in during severe winters. No surface disturbance would be allowed in identified wintering areas (serviceberry patches) for Columbian sharp-tailed grouse.

- **Visual Resources:** In Visual Resource Management (VRM) Class III visible from State, County or BLM roads (Appendix M: Areas Visible from Main Roads in VRM Class III): Drilling pads would not be located on ridgelines; Resource roads would not be located directly off these public roads, unless it is shown to be visibly less obtrusive than creating a new collector road; Low impact road design would be used in topography with less than 5% slope (see Appendix L, for a description of low impact road design); Also in these same areas, pad sizes would be minimized by using pitless, shared pit or closed system drilling; Where topography would allow, interim reclamation for pits and pads would occur within one year of the spud date.

- **Sand Hills SMA:** This area is a popular hunting spot and is generally isolated from development. There is currently an extensive road network in this area, mostly two tracks. The gently rolling terrain has stabilized sand dunes and unique vegetation communities contribute to high wildlife values. This area would need reduced road densities and restrict some public access conditions, especially on newly constructed roads. To develop additional roads, operators would need to reclaim mile for mile current roads in the area, plus do reclamation on existing roads to reduce road density to 3 mile/mi^2. Fences would be converted to BLM standards for improved wildlife passage. Surface disturbance would be limited in silver sagebrush/ bitterbrush communities in addition to those identified for vegetation resources. No surface disturbance would be allowed within the 18 acres surrounding the historical JO Ranch buildings.

- **Cow Butte/Wild Cow SMA:** This area is a popular hunting spot and is generally isolated from development. There is currently an extensive road network in this area, mostly two tracks and improved dirt roads. Terrain is generally steep, with highly erosive soils. The area has high wildlife values due to the vegetation communities. Road

densities would not exceed 3 miles/mi^2. Development protection measures would reduce pad density. Fences would be converted to BLM standards for improved wildlife passage.

- **Historic Trails SMA:** Historical trails are a unique cultural resource documenting the difficult journeys made in the early West. Three trails are eligible for the National Register of Historic Places in the ARPA . These areas would receive the following development protection measures: Low impact road design would be used and interim reclamation would be completed within one year of the spud date on the well; no surface disturbance would be allowed within ¼ mile of contributing segments; road or pipeline collocation would be required and trail crossings permitted only in areas of previous disturbance. Extensive efforts would be made to minimize the visual impact and surface disturbance.

- **Upper Muddy Creek Watershed/Grizzly SMA:** Muddy Creek contains critical habitat for BLM sensitive fish species. The area is generally isolated from development, with almost no legal public access. There is currently an extensive road network in this area comprised of mostly two tracks. In general it has poor soils and high wildlife values. Current road densities and public access conditions would be maintained. To develop additional roads, operators would need to reclaim mile for mile current roads in the area, plus do reclamation on existing roads to reduce road density to 3 mile/mi^2. Fences would be converted to BLM standards for improved wildlife passage. Detailed planning, specific to this area would be required, and roads in general would require more mitigation and design than in other areas. Where slopes are generally steeper than 8%, no surface disturbance would be allowed (44% of the SMA in the project area). No new road crossings of Muddy Creek would be allowed.

2.3 FEATURES COMMON TO ALL ACTION ALTERNATIVES

The Proposed Action, Alternative B, and Alternative C have numerous actions in common. The Proposed Action and Alternative B anticipate up to 1,800 natural gas wells to coal formations, and up to 200 natural gas wells to conventional formations with a combined number of wells at 2,000. While Alternative C also analyzes up to 2000 wells, the precise number that can be approved under the Alternative may be less depending on the specific locations at which development is proposed. If site specific development proposals are outside areas with development protection measures, then it is likely that 2,000 wells may be drilled. Conversely, if proposals are received for drilling in areas with development protection measures, a lower number of wells may be approved and drilled.

Another similarity between the action alternatives is the timing and rate of gas well development. The annual number of wells to be drilled is detailed in Figure 4-6 Proposed Action Annual Drilling Assumptions by Well Type. While economic conditions, drill rig and construction equipment availability, weather and other conditions could lower the actual number of wells drilled, any such effect is expected to be similar across all the alternatives.

All three alternatives envision the same ultimate extent of development. Coalbed Natural Gas (CBNG) resources would be extracted from those areas found to have natural gas in feasible and economic quantities. Development of natural gas from conventional formations would be similar under all three alternatives. Construction, location, and operation of facilities would be similar under the Proposed Action and Alternative B.

Surface disturbance amounts, both long term and short term, are envisioned to be similar under the Proposed Action and Alternative B. Reclamation timing and amounts, including short term, interim, and long term would also be similar for both alternatives. The number of wells per section would be up to 8 for the two alternatives.

All three alternatives require the sub-surface re-injection of produced water as a disposal method, with a limited surface discharge under permits issued previously by the State of Wyoming. No addition surface discharges are proposed under any of the alternatives. If alternative uses of the produced water are identified and proposed for use, they can be considered and approved separately under another NEPA analysis and decision.

2.4 FEATURES UNIQUE TO ACTION ALTERATIVES

Compared to the Proposed Action and Alternative C, Alternative B has unique provisions. Alternative B proposes that development within the ARPA occurs in three distinct phases, with construction activities limited to one of the areas at a time. Each of the three areas would be developed separately, and in turn, after construction of oil and gas facilities and interim reclamation in the preceding area is completed.

Compared to the Proposed Action and Alternative B, Alternative C's unique provisions are the use of development protection measures designed to reduce adverse impacts to important resource values such as crucial winter range, sage grouse nest and brood rearing habitats, and areas of sensitive visual and cultural resources. Another example of sensitive resource values is found in areas where reclamation is expected to be difficult such and areas of high run-off potential and soils with excess salts. In addition, the extent and scale of the various development protection measures would limit surface disturbance and pad locations to 4 or less across broad expanses of the ARPA.

Compared to Alternative B and Alternative C, the Proposed Action would not have the phased development provisions of Alternative B, nor would development be reduced by the development protection measures provided for in Alternative C.

2.5 ALTERNATIVES CONSIDERED AND ELIMINATED FROM DETAILED STUDY

Four alternatives were considered and eliminated from detailed study. The alternatives and the reasons for eliminating them from detailed study are described below.

2.5.1 3,880 Natural Gas Wells from 3,880 Well Locations

During the scoping process, which was initiated in June of 2001, the Operators believed that a maximum of 3,880 gas wells from 3,880 well locations would be required to fully develop the ARPA. During the timeframe between scoping and the preparation of this EIS, BLM authorized a limited amount of exploration wells to allow for the acquisition of data necessary to determine which coals are gas productive, what density of wells is needed, which drilling and completion techniques are economical, and if dewatering of coals can be achieved.

The information obtained during interim drilling has provided technical data that indicates it would no longer be necessary to drill 3,880 wells at individual locations to fully develop the potential gas resources within the ARPA.

Definitive predictions on the final number of wells and timing of drilling operations are not currently possible due to the fact that the technical information being gathered by the exploration drilling has not been completed to date and this information would play a significant part in the evaluation and determination of the number of wells needed to economically and efficiently develop this gas reservoir in the Atlantic Rim Natural Gas Project area.

2.5.2 Directional Drilling

Requiring that the operators use directional drilling as a technique was considered. In a June, 2005 memorandum, the Reservoir Management Group (RMG) of the Wyoming Bureau of Land Management stated that extensive directional drilling does not appear to be a viable technical or economic alternative for natural gas extraction in the Atlantic Rim EIS area. Requiring the operators to use directional drilling throughout the project area was suggested in comments to scoping from the public, based on the premise that reduced numbers of wells, and corresponding roads, pipelines and infrastructure would reduce habitat loss and wildlife disturbance.

The Atlantic Rim project area contains areas where the amount of surface disturbance would be limited due to resource concerns, such as proximity to known sage grouse leks or areas where the slopes are greater than 25%. Operators planning development activities would be able to anticipate, or would be advised by the BLM at site specific on-site reviews, the location of those areas with surface occupancy constraints and design their projects accordingly. Requiring the operators to use directional drilling for all wells regardless of surface conditions, topography, or subsurface geology would not be reasonable. Using such a technique without regard for local conditions may deter or preclude an operator from maximizing the recovery of the gas resource in the most economical and efficient manner.

2.5.3 Produced Water Disposal and Treatment Options

Among the activities proposed by the operators is the re-injection of waste waters produced during development and operation of each gas well. Some of the produced water would be discharged in regulated tanks for the use of wildlife and livestock. Several alternatives to re-injecting water from coal and other geologic formations were considered. Alternatives to re-injecting the produced water include several disposal methods: Water treatment with discharge onto land surface; surface discharge without treatment; storage in evaporation / infiltration ponds; transmission of produced water by pipeline from the Colorado River watershed to either the Great Divide Basin or North Platte River watershed with discharge onto land surfaces.

Produced waste water has varying concentrations of minerals and salts, and usually needs to be treated to make it usable or to meet water quality standards. For example under the Colorado River Salinity Pact, water discharged within the watershed must not add more than 1 ton per day of salts to the Colorado River system. If the local geology lends itself to re-injecting the produced water back into other geologic formations adjacent to or near the formations from which the gas was extracted then this is the preferred method of disposal. Other methods of disposal of produced water, especially when it must be treated or transported or both prior to disposal tend to be more costly and may have inherent logistical and engineering problems. Because of these reasons other alternatives for disposing of produced water were considered and eliminated from detailed study.

A portion of the proposed action for the ARPA is re-injection of produced water, with the exception of limited closed water discharge into regulated troughs or tanks for livestock and wildlife drinking water; and a limited surface discharge under State of Wyoming permits issued prior to the inception of the ARPA. Re-injection of produced water removes the water from coal seams and places it into geologic formations as permitted by the State of Wyoming. In this event surface impacts from the produced water are avoided, including in part erosion, changes to vegetation communities, and salinity issues relating to water release within the Colorado River basin. Beneficial uses of ARPA produced water, while not identified or proposed at this time, may be come forward in the future. When and if such proposals come forward State of Wyoming approvals under the State's various permitting authorities would be required. In addition, the BLM would review and approve or disapprove any such proposal based on the specifics of the proposal and the BLM's authorities and responsibilities under the National Environmental Policy Act and the Federal Land Policy and Management Act.

A portion of the proposed action for the ARPA is re-injection of produced water, with the exception of limited closed water discharge into regulated troughs or tanks for livestock and wildlife drinking water; and a limited surface discharge under State of Wyoming permits issued prior to the inception of the ARPA. Re-injection of produced water removes the water from coal seams and places it into geologic formations as permitted by the State of Wyoming. In this event surface impacts from the produced water are avoided, including in part erosion, changes to vegetation communities, and salinity issues relating to water release within the Colorado River basin. Beneficial uses of ARPA produced water, while not identified or proposed at this time, may be come forward in the future. When and if such proposals come forward State of Wyoming approvals under the State's various permitting authorities would be required. In addition, the BLM would review and approve or disapprove any such proposal based on the specifics of the proposal and the BLM's authorities and responsibilities under the National Environmental Policy Act and the Federal Land Policy and Management Act.

2.5.4 Powerlines and Electricification

The operators determined that it would not be economically feasible or practical at this time because of the lack of knowledge of exactly what lines and facilities would be needed and the exorbitant cost of construction of the infrastructure (powerlines, substations, etc.) to centralize facilities so this alternative was eliminated from detailed study. Any powerline proposals for above ground electrical distribution would require an additional NEPA analysis, either in the form of an EIS or EA, depending at least in part on the nature and extent of the proposal.

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Geology / Minerals / Paleontology				
Geology	Potential increased risk of mass movements, flooding, or accelerated erosion	Not significant	Same as PA	Similar to PA, but less due to steep slope restrictions
Minerals	Depletion of petroleum and CBNG reserves	Not significant	Same as PA	Same as PA
Paleontology	Potential for damage/destruction but also discovery of important fossils during construction	Not significant	Same as PA	Same as PA
Soils				
Potential for soil erosion, runoff, and sedimentation	Many areas would exceed significance criteria for soils	Impacts exceed significance criteria	Many areas would exceed significance criteria for soils	Some localized areas would exceed significance criteria.
Revegetation potential of disturbed soils	Low to moderate	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Removal/damage of biological soil crusts	Some crusts may be damaged/removed as a result of the Proposed Action	Some crusts may be damaged/removed	Same as Proposed Action	Fewer crusts may be damaged/removed
Water Resources				
Surface Waters				
Impacts to Waterbodies with Impairments or Threats on the State of Wyoming's 2004 303d list.	Increased sediment loads would lead to **significant** impacts to Muddy Creek west of State Hwy 789 and could lead to the relisting of many of the stream Muddy Creek segments.	Would **not** lead to significant impacts to waterbodies with impairments or threats.	Increased sediment loads would lead to **significant** impacts to Muddy Creek west of State Hwy 789 and could lead to the relisting of many of the stream Muddy Creek segments.	Due to development protection measures for SMAs and water resources, impacts to Muddy Creek listed segments would **not** likely be significant.

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Increased Salinity loads in the Colorado River System	Would increase salt loading above background conditions, impacts would be **significant**.	Salt loads would **not** increase measurably above background conditions	Would increase salt loading above background conditions, impacts would be **significant**.	Salt loads would be measurably higher, but are **not** likely to be significant.
Wetlands	Changes in hydrologic function in wetlands would occur, indirect impacts could be **significant**. Direct impacts would **not** be significant due standard mitigation to avoid these areas.	Would **not** lead to significant impacts to wetlands.	Changes in hydrologic function in wetlands would occur, indirect impacts could be **significant**. Direct impacts would **not** be significant due standard mitigation to avoid these areas.	Direct and indirect impacts are **not** likely to be significant due to development protection measures for water resources.
Stream Flow Characteristics	Changes in hydrologic function would occur, indirect impacts could be **significant**.	Would **not** lead to significant impacts to Streamflow characteristics.	Changes in hydrologic function would occur, indirect impacts could be **significant**, but are less likely than under the PA.	Impacts are **not** likely to be significant, since changes in hydrologic function are less likely to occur due to development protection measures for water resources
Changes in geomorphology due to increased surface runoff, erosion and increases in sediment loads.	Would occur in localized areas and cumulative impacts would be **significant**.	Would only occur in localized areas, impacts would **not** be significant.	Would occur in localized areas and cumulative impacts would be **significant**.	Due to development protection measures for SMAs and water resources, impacts would **not** likely be significant.

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Healthy Rangeland Standards for Water Resources	Wetland areas, water quality and watershed function would fail in areas due to indirect project impacts, impacts would be **significant**.	Could contribute to the failure of some areas, **not** likely to be significant.	Impacts would be focused and greater in individual areas, but for less time. Better planning may reduce impact, but is still likely lead to **significant** impacts.	Could contribute to the failure of some areas, **not** likely to be significant due to development protection measures for vegetation and water resources.
Ground Water				
Springs, seeps and artesian wells	**Not** likely to be significantly impacted some short-term reduction in flow in artesian wells.	**Not** likely to be significantly impacted.	**Not** likely to be significantly impacted some short-term reduction in flow in artesian wells.	**Not** likely to be significantly impacted some short-term reduction in flow in artesian wells.
Groundwater quality diminished	**Not** likely to be significantly impacted.	**Not** likely to be significantly impacted.	**Not** likely to be significantly impacted.	**Not** likely to be significantly impacted.
Depth to groundwater in permitted wells.	**Not** likely to be significantly impacted.	**Not** likely to be significantly impacted.	**Not** likely to be significantly impacted.	**Not** likely to be significantly impacted.
Range and Other Land Uses				
Range – Change in AUMs, animal death loss and disturbance to operations and management facilities	Increases in death loss; disturbance to management operations and facilities; reduced forage from dust and reduced productivity on a 1/3 of the area; increased erosion from roads that reduces productivity; likely reductions in livestock use, operators may suspend use; significant impacts	Impacts similar to PA but such small scale; not significant	Impacts sequential by regions; would initially affect specific operations at different times, but long-term impacts similar to PA, except operators likely to suspend use due to the intensity of development in the active area; significant impacts	Approximately 64 percent less disturbance to forage than PA; impacts from reclamation similar to PA, but mitigation for dust and erosion and overall less disturbance would reduce these impacts, mitigation would reduce animal death loss and require consultation; likely reductions/suspended use in pastures or small regions; long-term impacts would not be significant

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Vegetation				
Vegetation – erosion impacts from 1/3 ARPA with slopes > 8%, alkali sage sites	41% of ARPA affected by increased erosion from roads on moderate to steep slopes and alkali sage community prone to erosion; long-term loss of productivity cover and composition; significant impacts	Impacts similar to PA but such small scale; not significant	Impacts similar to PA; suspended grazing would lead to more rapid reclamation, greater ratio of grasses to shrubs; significant impacts	Reduced surface disturbance and additional mitigation for roads on these sites would create low impacts to vegetation; suspended grazing would lead to more rapid reclamation, greater ratio of grasses to shrubs; not significant
Riparian/wetland communities	Indirect affects from erosion and altered runoff patterns from adjacent uplands; significant impacts	These communities not impacted by IDP	Impacts similar to PA, significant impacts	Reduced surface disturbance and additional mitigation for roads on upland sites would reduce impacts to riparian/wetland vegetation; not be significant
Vegetation – direct loss due to disturbance and indirect impacts from dust	Long-term loss of shrubs on Wyoming and alkali sagebrush sites; 20 to 35% of forage lost or unusable do to dust; shifting antelope use and lead to long-term loss of plants and canopy cover; significant impacts	Impacts similar to PA but such small scale; not significant	Impacts similar to PA; significant impacts	Approximately 64 percent less disturbance to vegetation; construction and treatment of roads to reduce dust would create low impact to vegetation; may not be significant if overall browse use rate remains at moderate levels

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Vegetation – aspen and mountain shrub communities that failed Rangeland Health Standards	Additional disturbance from development would exacerbate the failed standard; increased difficulty in meeting this Standard in the future; long-term significant impacts	These communities not impacted by IDP	Impacts similar to PA; significant impacts	These communities would be avoided on public land with potential disturbance on private/State lands; significant impacts
Spread of weeds	Potential for spread or new infestation on disturbed sites is high to very high; impacts would not exceed significance criteria	Weed infestation has occurred on existing PODs and roads. Impacts exceed significance criteria	Potential for spread or new infestation on disturbed sites is high to very high and disturbed acreage is same as Proposed Action; Impacts would not exceed significance criteria	Potential for spread or new infestation on disturbed sites is high to very high, but development protection measures would reduce surface disturbance acreage by approximately 64 percent and reduced road densities would reduce acreage susceptible to infestation. Impacts would not exceed significance criteria.

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Wildlife				
Impacts to general wildlife habitat	Impacts on shrub dependant songbird nesting and foraging habitats would exceed the significance criteria. The impact to small mammals would not exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as the Proposed Action; However development would be concentrated within one third of the project area at any one time during the construction phase.(5 to 6 Years)	Impacts would not exceed the significance criteria for small mammals and songbirds.
Impacts to greater sage-grouse and Columbian sharp-tailed grouse	The proposed action activities would exceed the significance criteria	The impacts would not exceed the significance criteria.	Same as the proposed action	Impacts would exceed the significance criteria
Impacts to pronghorn	This level of development would exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as the Proposed Action	Direct and indirect impacts would not exceed the significance criteria.
Impacts to mule deer	This level of development would exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as the Proposed Action	Indirect and direct impacts would exceed the significance criteria.
Impacts to elk	This level of development would exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as the Proposed Action	Impacts would exceed the significance criteria.
Impacts to raptors	Impacts are not expected to exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as the Proposed Action	Same as the Proposed Action

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Impacts to T&E, Proposed, and Candidate species	The impacts would not exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as the Proposed Action	Same as the Proposed Action
Impacts to Sensitive species, except grouse, raptors, sagebrush-obligate songbird species above	The impacts would not exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as the Proposed Action	Same as the Proposed Action
Impacts to T&E fishes occurring downstream of ARPA	Project-related impacts are not anticipated.	Same as PA	Same as PA	Same as PA
Impacts to BLM sensitive fishes	Would exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as PA	The impacts would not exceed the significance criteria.
	Impacts would exceed the significance criteria.	The impacts would not exceed the significance criteria.	Same as PA	The impacts would not exceed the significance criteria.
Recreation				
Hunting and wildlife viewing	Displacement of wildlife and loss of a natural-appearing setting would make the ARPA undesirable for hunting or wildlife viewing. These visitors would be displaced and impacts would exceed significance criteria.	Not significant	Same as PA	Same as PA

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Camping	Impacts to scenery, noise, dust and human activity would reduce the ARPA's desirability as a place to camp; Impacts would be significant	Not significant	Same as PA	Same as PA
Access to ARPA	Impacts would be significant	Not significant	Same as PA	Same as PA
Traffic	Impacts would be significant	Not significant	Same as PA	Same as PA
Noise, dust and human activity	Impacts would be significant.	Not significant	Same as PA	Impacts would not be significant
Visual Resources				
Hunting, wildlife viewing, pleasure driving, mountain biking	Impacts would be significant	Not significant	Same as PA	Impacts would not be significant
Management Objectives for VRM Class III	Impacts would be significant	Not significant	Same as PA	Impacts would not be significant
Cultural				
Impacts to cultural resources as a result of construction activities	Estimate that 126 sites could be affected as a result of 15,803 acres of new surface disturbance.	None expected beyond those identified in the current POD EAs	Same as Proposed Action (over time)	Approximately 167 sites could be indirectly protected as a result of the elimination from development of the ¼ mile trail buffer. Limited access resulting in reduction of unauthorized site collection.

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Impacts to setting where it contributes to site eligibility	Estimate that a maximum of about 142,763 acres between the ¼ mile avoidance area and the 2 mile view shed buffer would be affected and subject to extensive mitigation measures.	None expected beyond those identified in the current POD EAs	Same as Proposed Action (over time)	Reduced surface disturbance would result in a reduction of visual impacts. Limited access resulting in reduction of unauthorized site collection.

Socioeconomics

Compliance with RMP	YES	YES	YES	YES
Drilling/Field Development	2000 wells/20 years		Same as PA[a]	Could potentially be lower than PA if some areas are precluded from drilling because of environmental constraints

Economic Effects

Direct Expenditures for Drilling/Field Development	$981 Million	None	Same as PA	Drilling expenditures could be higher for some wells depending on mitigation measures.
Total SW Wyoming Economic Impact Related to Drilling/Field Development	$1.25 Billion	None	Same as PA	Could be less than PA if fewer wells are drilled
Average Annual Jobs (Annual Job Equivalents) Direct, Indirect and Induced	578		Same as PA	Could be less than PA depending on reductions in wells and production
Total Economic Impact Related to Production	$ 6.4 Billion	None	Same as PA	Could be less than PA if fewer wells are drilled Same as PA

[a] Same as Proposed Action

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Impacts to other economic activities within the ARPA	Potential for reductions in grazing economy resulting from disturbance and resultant reductions in AUMs	None	Same as PA	Reductions in grazing could be lower than PA if total number of wells is reduced
	Potential for reductions in recreation/hunting economy.	None	Same as PA, except somewhat localized during activity in each zone.	Diminished potential for reductions in recreation/hunting associated with success of impact avoidance/mitigation measures
Employment, Population and Housing				
Peak Year Drilling & Production Employment	1,488	None	Same as PA	Could be lower than PA if fewer wells are drilled
Peak Year Population Impact	1,092	None	Same as PA	Could be lower than PA if fewer wells are drilled
Peak Year Housing Demand	441 Units (228 Temporary, 213 Longer-term)	None	Same as PA	Could be lower than PA if fewer wells are drilled
Local Government Facility and Service Demand				

Local Government Facility and Service Demand				
Local Government Facility and Service Demand	Most local government facilities have excess capacity.	None	Same as PA	Same as PA
	Some services may need to expand to accommodate Proposed Action-related growth.	None	Same as PA	Same as PA
	Carbon County should have adequate revenue to offset cost of increased service demand, but revenues may lag demand.	None	Same as PA	Same as PA

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
	Municipalities may not receive direct project-related revenues in sufficient amounts to offset costs of needed expansion	None	Same as PA	Same as PA
Federal, State and Local Revenues				
LOP[b] Property Taxes	$349 Million	None	Same as PA	Could be lower than PA if fewer wells are drilled
LOP County & Special District Share	$96 Million	None	Same as PA	
LOP Schools Share	$253 Million	None	Same as PA	
LOP Federal Mineral Royalties	$320 Million	None	Same as PA	
LOP State Wyoming Share FMR	$160 Million	None	Same as PA	
LOP Wyoming Severance Tax	$296 Million	None	Same as PA	
Drilling and Filed Development Sales and Use Tax	$10 Million	None	Same as PA	
LOP Total Property /Mineral Royalty / Severance / Sales and Use Tax	$975 Million	None	May delay revenue for those entities outside of active zones	
Local Attitudes Opinions and Lifestyles				
Change in attitudes/lifestyles for county residents and users of the ARPA	General support in county for development of resources but concern about change in relatively undeveloped landscape and resultant effects on grazing operations, recreation opportunities and change in character of the area.	None	Concern more localized during development of each zone.	Potential for reduced concern and dissatisfaction based on success of impact avoidance and mitigation measures

[b] Total over the life of the project

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Environmental Justice	ASK MARY! Economic benefits for poor agricultural communities median income improvement, infrastructure improvements			
Transportation				
Peak Year AADT[c] Carbon County Roads	Increased Traffic	None	Focused around active Zone	Could be lower than PA if fewer wells are drilled
CCR 605N (20 Mile Road)	184			
CCR 608 (Wild Cow Road)	230			
CCR 501 (Cherry Grove Road)	4			
Peak Year AADT Affected Highways	Increased Traffic	None	Focused around active Zone	Could be lower than PA if fewer wells are drilled
I-80 (Junction WY 789)	213 (96 trucks)			
WY 789 (Creston Jct. - Baggs)	240 (108 trucks)			
WY 70 (Dixon west)	42 (19 trucks)			
Impacts on County Roads	Additional maintenance costs to the county, offset by property tax revenues from production, but may be a lag between the time maintenance demand occurs and production-related revenues flow.	None	Same as PA except that maintenance demand would be localized around active zones	Same as PA
Coordinated Transportation Planning	Operators would participate in a coordinated transportation planning process, updated annually	None	Same as PA except that the transportation network would be more intensively planned for each zone, possibly resulting in a smaller road footprint.	Same as PA, except that the transportation network would be specifically designed to avoid areas with high environmental values

[c] Average Annual Daily Travel

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Health and Safety				
Occupational Hazards	Potential for accidents primarily involving project workers	None	Increased risk of occupational accidents associated with concentrations of activity in smaller area.	Could be lower than PA if fewer wells are drilled
Hazardous Materials	Increased potential for incidents involving hazardous materials accruing primarily to project workers	None	Same as PA	Could be lower than PA if fewer wells are drilled
Other Risks & Hazards	Increased potential for vehicle accidents involving both project workers and visitors, weather-related incidents involving project workers and wildfire incidents, and fire-arms related incidents associated with hunting near project activities	None	Increased risk of vehicle accidents associated with concentrations of activity in smaller area.	Could be lower than PA if fewer wells are drilled

Resource	Proposed Action	Alt A: No Action	Alternative B	Alternative C
Noise				
Construction	Drilling and field development activities would temporarily exceed 55 dBA threshold at drilling and construction sites. Exposure limited to project workers who are protected by noise regulations and, temporarily, to other visitors to the Project area.	None	Noise impacts would be focused within Active Zone	Same as PA
Production Operations	Workovers and other maintenance activities would temporarily exceed 55 dBA threshold, project workers would be the primarily group exposed other than brief exposure to visitors. Compressor stations would also exceed 55 dBA threshold, no compressor stations would be located near residences.	None	Same as PA	Same as PA

CHAPTER 3

AFFECTED ENVIRONMENT

CHAPTER 3

AFFECTED ENVIRONMENT

3.0 INTRODUCTION

The Affected Environment chapter of this environmental impact statement (EIS) for the proposed Atlantic Rim Natural Gas Project discusses environmental, social, and economic factors as they currently exist within the Atlantic Rim Project Area (ARPA). The material presented here has been guided by management issues identified by the Bureau of Land Management (BLM), Great Divide Resource Area (GDRA), public scoping, and by interdisciplinary field analysis of the area.

This proposal could potentially affect critical elements of the human environment as listed in BLM's National Environmental Policy Act (NEPA) Handbook H-1790-1 (USDI-BLM 1988). The critical elements of the human environment, their status in the ARPA and their potential to be affected by the proposed project are listed in Table 3-1.

Table 3-1. Critical Elements of the Human Environment[1], Atlantic Rim Natural Gas Project, Carbon County, Wyoming.

Element	Status on the ARPA	Addressed in text of EIS
Air quality	Potentially affected	Yes
Areas of critical environmental concern	Potentially affected	Yes
Cultural resources	Potentially affected	Yes
Environmental justice	Potentially affected	Yes
Prime or unique farmlands	None present	No
Floodplains	None present	Yes
Native American religious concerns	Potentially affected	Yes
Noxious weeds	Potentially affected	Yes
Threatened and endangered species	Potentially affected	Yes
Hazardous or solid wastes	Potentially affected	Yes
Water quality (surface and ground water)	Potentially affected	Yes
Wild and scenic rivers	None present	No
Wetlands/riparian zones	Potentially affected	Yes
Wilderness	None present	No

[1] As listed in BLM *National Environmental Policy Act Handbook H-1790-1* (BLM 1988) and subsequent Executive Order

In addition to the critical elements, this EIS discusses potential effects of the project on geology/paleontology/soils, water resources, vegetation, wildlife, special status species, noise, visual resources, recreation and socioeconomic considerations.

3.1 GEOLOGY / MINERALS / PALEONTOLOGY

3.1.1 Geology Resources

3.1.1.1 Regional Geologic Overview

The ARPA straddles the west margin of the Continental Divide and lies within the southeastern arm of the Great Divide Basin sub-basin region of the Greater Green River Basin (Johnson 1985) of southernmost central Wyoming. Structurally, rocks in the ARPA dip generally northwest, west, and southwest off the arcuate structural high of the Sierra Madre Range westward into the eastern edges of the Greater Green River and Washakie structural basins.

The west flank of the Sierra Madre is bounded by a major eastward dipping reverse fault system along which it was elevated over the eastern edge of the Greater Green River Basin (including the Washakie Basin) during the Laramide Orogeny which occurred in the late Cretaceous to Early Tertiary time. These reverse faults are not exposed at the surface, but rather lie buried beneath Early Tertiary sediments filling the basin. The Washakie Basin to the west, into which the surface rocks dip, is bound by east-west oriented structural highs, the Wamsutter Arch and Cherokee Ridge, to the north and south, respectively. The structural axis of Cherokee Ridge trends along the Wyoming-Colorado State line and separates the extreme southeastern arm of the Greater Green River Basin of Wyoming from the Sand Wash Basin of Colorado. Numerous faults occur along Cherokee Ridge, many of which show evidence of recurrent motion throughout the last 20 million years. None of these, however, show any indication of Quaternary movement (Case et al. 1994).

Geologic mapping by the USGS and Wyoming Geologic Survey (Weitz and Love 1952, Love 1970, Love and Christiansen 1985, Love et al. 1993, Roehler 1973, 1977, 1985) document that the ARPA is underlain at the surface by sedimentary deposits of Quaternary, Tertiary and Late Cretaceous age. These deposits are underlain by Phanerozoic age sedimentary rocks of Cretaceous to Cambrian age, which are in turn underlain by Precambrian metamorphic bedrock that comprises part of the ancient North American craton and exceeds 2 billion years in age.

Information on geologic units preserved at the surface and beneath the project is provided in Table 3-2. Rock terminology for the Cretaceous (Mesaverde Group) is complicated in that scientific studies of these rocks reference a number of different formations within the ARPA. Although the Wyoming Chart of Stratigraphic Nomenclature lists the Almond, Ericson, Rock Springs, and Blair formations within the Mesaverde Group in the Washakie Basin, alternative terminology has been used for these same rocks by authors describing the coals of the Mesaverde. Rock equivalent names for the Ericson Sandstone include the Williams Fork Formation or Pine Ridge Sandstone; for the Rock Springs Formation include the Allen Ridge Sandstone Formations; and for the Blair Formation, the Haystacks Mountain Formation.

Additional details on surface deposits are provided below.

Table 3-2. Surface and subsurface geologic deposits – Atlantic Rim Project Area.

Geologic Deposit	Geologic Age	Environment/Lithology	Resources
Surface Deposits			
Unnamed Quaternary Deposits	Holocene-Pleistocene	Eolian/fluvial/ landslide. Sand, gravel, clays, weathered in place residuum from exposed outcrops	None reported within area, economic deposits of windblown sand reported 20-30 miles NNE of the town of Baggs, Wyoming, just east of the project area
Browns Park Formation	Miocene	Alluvial fan/volcanic, Polymictic conglomerates, tuffaceous sandstone and mudstones	Vertebrate and plant fossils (BLM Condtion 2). No mineral resources reported within area. Uranium produced in adjacent areas (Ketchum Buttes, Miller Hill, Poison Basin).
Wasatch Formation	Early Eocene	Terrestrial:fluvial/flood plain/swamp, drab to varicolored mudstone, sandstone, carbonaceous shale and coal.	Vertebrate, invertebrate and plant fossils (BLM Condition 2). Coal. Petroleum in subsurface. Uranium reported in adjacent areas near Wamsutter Creston and Latham
Fort Union Formation	Paleocene	Terrestrial: fluvial/flood plain/swamp, chiefly somber colored sandstones, mudstones, carbonaceous shales and coals.	Vertebrates, invertebate and plant fossils (BLM Condition 2). Coal. Coalbed Natural Gas.
Lance Formation	Late Cretaceous	Terrestrial: fluvial/flood plain/swamp, brown and gray sandstone , shale and mudstone, coals, and carbonaceous shales.	Vertebrate, invertebrate and plant fossil (BLM Condition 2). Coal. Coalbed Natural Gas.
Fox Hills Sandstone	Late Cretaceous	Marine: shoreline, light-colored sandstone and gray sandy shale	Vertebrate and invertebrate fossils (BLM Condition 3). No mineral resources reported.
Lewis Shale	Late Cretaceous	Marine: nearshore to offshore, gray shale containing gray, brown sandstones.	Invertebrate fossils. Petroleum in Espy Field.

Table 3-2. Continued.

Geologic Deposit		Geologic Age	Environment/Lithology	Resources
Mesaverde Group	Almond Formation	Late Cretaceous	Marine, Terrestrial, deltaic: white and brown sandstone, sandy shale, coal, carbonaceous shale	Vertebrate, invertebrate and plant fossils (BLM Condition 2) Coal. Coalbed Natural Gas. Petroleum in Baldy Butte, Cherokee Creek, Cow Creek, Creston, Deep Gulch, Espy, Savery Fields.
	Ericson Sandstone (=Pine Ridge or Williams Fork Formation)	Late Cretaceous	Marine: coastal plain, estuary/beach , white sandstone, lenticular conglomerate, coal	
	Rock Springs (=Allen Ridge or Iles) Formation	Late Cretaceous	Terrestrial, coastal plain white to brown sandstone, shale, mudstone, coal	
	Blair (=Haystack Mountains) Formation	Late Cretaceous	Marine:	
Subsurface				
Steele Shale (includes Shannon, Sussex Sandstones)		Late Cretaceous	Marine, gray shale, with numerous bentonites, sandstone	Petroleum in Browning Cherokee Creek, Cow Creek, Deep Creek, Deep Gulch, Sierra Madre Fields.
Niobrara Formation		Late Cretaceous	Marine, light-colored limestone, gray limey shale	Petroleum in Espy Field.
Frontier Formation		Late Cretaceous	Marine: deltaic, gray sandstone and sandy shale	Petroleum in Browns Hill, Cherokee Creek, Cow Creek, Deep Gulch, Sugar Creek Fields.
Mowry Shale		Late Cretaceous	Marine: silver-gray, hard siliceous shale, with abundant fish scales and bentonites	Bentonites, mined about 10 miles east of area.
Muddy Sandstone		Early Cretaceous	Marine: deltaic, gray to brown sandstone, conglomeratic	Petroleum in Browning, Deep Creek, Sugar Creek Fields.
Thermopolis Shale		Early Cretaceous	Marine, black, soft, fissile shale	None reported, oil and gas source rock

Table 3-2. Continued.

Geologic Deposit	Geologic Age	Environment/Lithology	Resources
Cloverly Formation (=Dakota Sandstone)	Early Cretaceous	Terrestrial, variegated mudstone, bentonitic, conglomeratic sandstone	Petroleum in Browning, Cherokee Creek Fields.
Morrison Formation	Jurassic	Terrestrial, varicolored mudstones, white sandstone, bentonite	Petroleum in Browning Field.
Sundance Formation	Jurassic	Marine, green-gray glauconitic sandstone and shale, underlain by red and gray non-glauconitic shale and sandstone	none reported
Nugget Sandstone	Triassic to Jurassic	Eolian, gray to red, massive to cross-bedded sandstone	Petroleum in Cow Creek, Deep Gulch Fields.
Chugwater Formation	Triassic	Terrestrial/mud flat, red shale and siltstone, sandstone	Petroleum in Browning Field.
Goose Egg Formation	Permian to Triassic	Marine, gray to olive dolomitic siltstone; red sandstone and siltstone, gypsum, halite, purple to white dolomite and limestone	none reported
Tensleep Sandstone	Pennsylvanian	Marine, white to gray sandstone with limestone and dolomite	Petroleum in Browning, Espy, Sugar Creek Fields.
Amsden Formation	Mississippian to Pennsylvanian	Marine, red and green shale and dolomite, persistent red to brown sandstone at base	none reported
Madison Limestone	Mississippian	Marine, glue-gray massive limestone and dolomite	none reported
Flathead Sandstone	Cambrian	Marine/shoreline, red, banded, quartzose sandstone	none reported
unnamed metamorphic rocks	Precambrian	Igneous/metamorphic, granitic and/or intrusive	none in area but in Sierra Madre contain ores of uranium, copper, silver, lead, zinc, gold, and barium industrial (building and decorative) grades of quartzite, marble, and granite

3.1.1.2 Quaternary Deposits

Quaternary deposits in the ARPA include widespread deposits of alluvium, colluvium and slope wash; eolian sand dunes; residuum developed on formations of Cretaceous (Lance and Lewis Formation and Mesaverde Group), Paleocene (Fort Union Formation), and Eocene (Wasatch Formation) age; and mass movement (including landslide) debris.

Tertiary – Browns Park Formation

The Miocene Browns Park Formation unconformably overlies all older rocks exposed at the surface within the ARPA, with its largest area of outcrop developed in the S1/2, T13N:R90W, where it overlies the Lewis Shale, Lance, Fort Union, and Wasatch Formations with angular unconformity. The Browns Park Formation continues north into the E1/3 of T14N:R90W, and the SE1/4 T15N:R90W, where it overlies the Mesaverde Group and Lewis Shale. Two large outliers of Browns Park Formation cap ridges form the highest elevations .in the ARPA, in the SE1/4, T17N:R90W, and the SE1/4, T18N:R90W, where they overlie truncated hogbacks expressed in the Mesaverde Group. Regionally, the Browns Park Formation consists of up to 1,000 feet (305m) of polymictic conglomerate (especially at the base of the formation), derived from Precambrian and Paleozoic sources, and tuffaceous sandstones and mudstones (Ritzma, 1949). Mudstones of the formation are known to be rich in montmorillonite, a swelling clay, and as a result, it is extensively involved in mass movement (earth flow) in some areas.

Tertiary – Wasatch Formation

Outliers of Tertiary age rocks are exposed at three places within the ARPA: (1) just northeast of the town of Baggs, in Sec. 35, T13N:R91W, where it overlies the Paleocene Fort Union Formation; and (2) as two distinct outliers capping the highest hills in the E1/2, T14N:R91W, overlying rocks of the Upper Cretaceous Lance Formation and Lewis Shale with angular unconformity.

These outliers include flat-lying sandstones and variegated mudstones of obvious Tertiary age that lie with marked angular unconformity on underlying older rocks. (Weitz and Love 1952) mapped the outlier rocks as the Wasatch Formation of Eocene age. Later, Love and Christiansen (1985) mapped them as rocks of the Browns Park Formation of Miocene age. The presence of well-indurated sandstones and variegated (including red) mudstones in these Tertiary deposits, which are like the Wasatch Formation (main body Member) and very unlike the Browns Park Formation, suggests the deposits are correctly identified as the Wasatch Formation. This interpretation is supported by the occurrence of rocks of the Wasatch Formation at the same elevation (about 7,200 feet) as these deposits a few miles to the west of Wyoming State Highway 789 at Flat Top Mountain. The nearest rocks of the Browns Park Formation occur several miles to the east at much higher elevations (7,600+ feet).

Regionally, the main body of the Wasatch Formation consists of up to 2,130 feet (650m) of drab to variegated mudstone, gray sandstone, carbonaceous shale, and coal (Bradley 1964, Sullivan 1980, Roehler 1985) that accumulated in alluvial channels and back swamps, as well as, on more distal floodplains. Mudstones and shales of the formation are readily eroded into badlands, but most of the sandstones are resistant and form prominent outcrops.

Tertiary – Fort Union Formation

The Paleocene Fort Union Formation is exposed in an arcuate outcrop that borders the entire western margin of the ARPA. Within this area proper, however, the formation is exposed only in a few minor areas, located in: the NE1/4, T13N:R91W and the C of T14N:R91W; in the NE1/4, T15N:R92W and the C of T16N:R92W; in the extreme NW1/4, T17N:R91W and NE1/4, T18N:R91W; and in the SW1/4, T19N:R90W.

Regionally, the Fort Union consists of up to 3,400 feet (1,037m) of discontinuous drab mudstones, sandstones, carbonaceous shales, and coal that accumulated in alluvial channels and floodplain back swamps (Sanders 1975). As much as 1,500 feet (457m) of Fort Union are exposed in the Riner Quadrangle, a few miles north of the project area (Sanders 1974). Like the Wasatch Formation, mudstones and shales of the formation readily eroded into badlands in places, and the sandstones are relatively resistant and form prominent outcrops.

The contact of the Fort Union Formation with the underlying Upper Cretaceous Lance Formation is everywhere marked by a pronounced angular unconformity and generally a thick channel sandstone (Roehler 1993). It is unknown if the Tertiary-Cretaceous boundary is preserved in the area, but certainly earliest Paleocene rocks are (See Section 3.1.3).

Upper Cretaceous – Lance Formation

The Latest Cretaceous Lance Formation consists of about 2,890 feet (881m) of interbedded gray sandstone and mudstone, carbonaceous shale and coal, and the formation crops out over the majority of the western part of the ARPA (Hettinger et al. 1991, Hettinger and Kirschbaum 1991). The sandstones of the formation are relatively resistant to erosion, so where the stratigraphy of the formation is dominated by them, a series of resistant ridges and high cliffs, or both are developed. In areas dominated by mudstones and shale the formation is largely eroded flat and soil and vegetation covered. In most places in the ARPA the Lance does not have a tendency to erode into badlands.

Regionally, the Lance overlies the Fox Hills Sandstone (Smith 1961, Gill et al. 1970, Hettinger et al. 1991, Roehler 1993), which is included in the Lewis Shale on many maps. To the east the Fox Hills may be absent, and the Lance directly overlies the Lewis Shale (Weitz and Love 1952, Love and Christiansen 1985). Further eastward, Lance rocks correlate with the Medicine Bow Formation (Merewether 1971) and farther west, the Lance thins to less than 197 feet (60m) on the west side of the Washakie Basin (Roehler 1985).

Upper Cretaceous – Lewis Shale

The Lance Formation is underlain by the Lewis Shale, and this relatively nonresistant unit occupies nearly all of the central part of the ARPA. The Lewis Shale consists chiefly of up to 1,500 feet (457m) of near shore marine shale, and thin, discontinuous stringer sandstones (Smith 1961, Roehler 1993). With the exception of the uppermost part of the formation, which contains a series of laterally extensive sandstones that weather to ridges and small cliffs, the Lewis Shale is not very resistant to erosion and forms a broad strike valley.

The Lewis Shale interfingers westward into the upper part of the Mesaverde Group, the Fox Hills Sandstone, and the lower part of the Lance Formation. Within the ARPA, the Lewis Shale is underlain in surface sections by the Mesaverde Group; however, farther north and east

(seaward), along the Sierra Madre Range and in the Laramie Basin, the Lewis Shale directly overlies the Steele Shale (Ritzma 1949, Roehler 1993).

Upper Cretaceous – Mesaverde Group

The Mesaverde Group is the oldest rock unit exposed within the ARPA and forms all surface outcrop of the eastern region of that area, with the exception of a few places where it is unconformably overlain by much younger Miocene rocks of the Browns Park Formation. The group consists of 1,125-2,000 feet (343-610m) of massive beach and shelf sandstones, interbedded with minor amounts of shale, carbonaceous shale, mudstone, and coal. The upper part of the group is dominated by sandstones, which are relatively resistant to erosion, and form prominent dip slopes that dip westward, forming the eastern boundary of the ARPA. Atlantic Rim, from which the project name is derived, is a series of these dip slope sandstones developed in the northeastern part of the area.

In the region of the ARPA, the Mesaverde is subdivided into three formations, from top to bottom, the Almond Formation, the Ericson (=Pine Ridge) Sandstone, and the Rock Springs (=Allen Ridge) Formation (Roehler 1993). All of these units intertongue to the east and north with the Steele Shale. The Ericson Sandstone and Rock Springs Formation are the lateral equivalents of the Williams Fork Formation and Iles Formation, respectively, in the Sand Wash Basin of Colorado, which contain important coal and potentially important coalbed natural gas resources. The terminology Williams Fork and Iles formations have been extended into Wyoming by authors describing subsurface coal deposits.

3.1.1.3 Geologic Hazards

Of known naturally occurring geologic hazards, fault generated earthquakes, floods, landslides or other mass movements among others, the most likely to affect the project area are mass movements that could be initiated on steep slopes. There are no known faults with evidence of Quaternary movement or earthquake epicenters mapped within the area (NEIC 2003, WGS 2003). A 4.3 Richter magnitude earthquake occurred April 4, 1999, a few miles northwest of the western boundary of the ARPA. The epicenter of this earthquake was located near Baldy Butte in T17N:R92W (41.45°N, 107.74°W). No other earthquake epicenters have been recorded in or immediately adjacent to the area in the past 100 years, indicating that this quake was probably an unusual event and that the area may not be very seismically active.

Pyrophoricity

Pyrophoricity (spontaneous combustion) has been cited as a potential hazard of coal gas development. Spontaneous combustion of coal has long been a concern for mankind and shallow coal mine fires in areas of abandoned mines are today still an environmental concern throughout the world (Lyman and Volkmer 2001).

Although spontaneous combustion of coal is unlikely to occur in naturally exposed outcrops of coal, because by the time coal is exposed by erosion it is already too degassed to ignite spontaneously (Coates and Heffern 1999), the presence of naturally occurring outcrops of clinker and baked shale show that it has happened in the past in the ARPA. Studies of in-situ coal gasification (UCG) conducted during the 1970s in Wyoming suggest that even under extreme efforts to maintain combustion (by injecting air into the burn zones) in underground coals ignited in bore holes, coal burning away from the ignition area cannot be sustained. Loss of permeability associated with plugging of fissures by tar and combustion products resulted in

the fires burning themselves out rather quickly. In their study of Powder River Basin coalbed natural gas wells, Lyman and Volkmer (1999) found that spontaneous combustion of coal beds during coalbed natural gas production is unlikely because completion methods, although "open-hole", configure the well to keep air, necessary for combustion, out of the system. "Even where the coal has been completely dewatered, insufficient oxygen is present for oxidation to be carried forward." After coal gas extraction is complete, CBNG wells leave no underground voids susceptible to subsidence and associated coal ignition as seen in abandoned underground mines, which are susceptible to spontaneous ignition.

Subsidence

Ground subsidence (resulting from withdrawal of coalbed natural gas related water) has also been cited as a potential hazard of CBNG development. A number of documented cases have demonstrated the association of withdrawal of underground fluids and subsidence. The best examples include specific sites in the San Joaquin Valley in California, Las Vegas, New Orleans, Houston, and Mexico City. Subsidence in these areas is chiefly related to removal of water for human consumption or agricultural use. Removal of water from underlying saturated, chiefly unconsolidated, and porous sand and gravel aquifers, lowers the water table and causes the previously saturated zones to compress, causing subsidence. Saturated unconsolidated sands and gravels and porous clays can compress significantly; in some cases as much as 29 feet of subsidence has resulted. The subsurface geologic conditions in the ARPA, however, differ significantly from these areas. The bedrock underlying the area is compacted and consolidated, and porosity is much lower. In comparison, unconsolidated sands and gravels and clays have porosity values as high as 50% and 88%, respectively (Poland 1984), whereas, values for consolidated clay (shale) and sand (sandstone) in the ARPA have porosity values as high as 10% and 30%, respectively (Freeze and Cherry 1979). Calculations of modeled ground subsidence associated with CBNG production for the Wyodak coal in the Powder River Basin, near Gillette, indicate that subsidence of less than ½ inch (1.27 cm) can be expected (Case et al. 2002). However, strata from which the CBNG would be withdrawn from in the ARPA occur much deeper in the subsurface than those in the Powder River Basin and any subsidence would be attenuated because of that increased depth and is not considered significant.

Mass Movement

Quaternary landslides occur primarily along the eastern edge of the project area, including from north to south, along the west side of Separation Peak, Atlantic Rim, Bridger Pass, Sand Hills, Cow Creek Butte, and along the east side of Muddy Mountain (Case and Larsen 1991). One of the largest of the mapped landslides occupies about 20 square miles of area in sections 25 and 26, T14N:R90W (Weitz and Love 1952). The displaced material includes rocks derived from the Miocene Browns Park Formation and underlying Lewis Shale and emplaced by movement from the southeast to the northwest. Similarly, most of the landslides mapped along the eastern boundary of the area are developed in the Browns Park Formation which contains tuffaceous and bentonitic clay beds rich in montmorillonite that are susceptible to swelling and mass movement when water saturated, especially where exposed on steep or undercut slopes.

Additional landslide debris is mapped around Doty Mountain (T17N:R91W), Wildhorse Butte (T14N:R91W) and Muddy Mountain (T13N:R89W). Mass movement in these areas is associated with steep slopes developed in the Lance Formation, Wasatch Formation, and Lewis Formation, respectively, all of which contain clay-rich shale beds that are also susceptible to mass movement when water saturated, especially where exposed on steep or undercut slopes.

3.1.2 Mineral Resources

Mineral resources within ARPA region include locatable mineral deposits of basal and precious metals, bentonite, gypsum, limestone, uranium, zeolite, gravel, and clinker, and leasable minerals such as oil, gas, coal, and coalbed natural gas.

3.1.2.1 Locatable Minerals

No economic deposits of locatable minerals are known to occur within the ARPA. Economic deposits of Quaternary windblown sand are developed 20-30 miles north-northeast of the town of Baggs, Wyoming, just east of the project area (Harris 1996). These are continuations of dune deposits that occur in the east central parts of the ARPA, but that are probably not thick enough to be economic.

Uranium-bearing prospects occur in the Browns Park Formation in: (1) the Ketchum Buttes District, adjacent to the ARPA in the NW1/4, T15N:R89W; (2) the Miller Hill Prospect, about ten miles south-southwest of Rawlins, in T18N:R88-89W; and (3) in the Poison Basin Uranium District, about ten miles west of the town of Baggs (Harris et al. 1985). Economically significant shows of uranium occur in coals of the main body of the Wasatch Formation north of Wamsutter, Wyoming (Masursky 1962), and in the region around the towns of Creston and Latham (Harris et al. 1985, Harris and King 1993), about fifteen miles west of the north edge of the ARPA. Uranium is also known in arkoses of the Battle Spring Formation of the central Great Divide Basin (Pipiringos 1961), which is in part equivalent to the upper part of the Wasatch Formation, which is exposed just west of the project boundary.

Gravel, preserved as Quaternary terrace and channel remnants, and clinker, associated with burnt coal seams occur at several locations within the ARPA. Some of these have been locally exploited and developed as gravel (W/2 Sec. 26, T14N:R91W and W/2, SW/4 Sec. 2, T14N: R90W) and clinker ("scoria") pits (W/2 Sec. 6, T15N:R91W, and NE/4 Sec. 1, T15N: R92W); other gravels (center of NW/4 Sec. 28, T16N:R92W and N/2 Sec. 22, T17N:R92W) and clinker (N/2 Sec. 5, T17N:R91W and SE/4, SE/4,SE/4 Sec. 35, T18N:R91W) have not.

3.1.2.2 Leasable Minerals

Coal and coalbed natural gas occur in Tertiary and Cretaceous age geologic formations, and oil and gas occur in geologic formations of Cretaceous, Jurassic, Triassic, and Pennsylvanian age underlying the project area.

Coal and Coalbed Natural Gas

<u>Fort Union Formation</u>

The Fort Union Formation of south and southwest Wyoming constitutes an enormous, largely untapped reserve of coal. Coals occur throughout the formation, but are thickest and most continuous in its lower part (the lower coal bearing unit) (Smith et al. 1972, Sanders 1974, 1975, Beaumont 1979, Edson 1979, Hettinger and Brown 1979, Honey and Roberts 1989, Honey and Hettinger 1989, Honey 1990, Jones 1991, Hettinger et al. 1991).

Within and adjacent to the ARPA, coal seams of the Fort Union comprise the Red Rim and China Butte coals. These coals are best developed from the southernmost parts of T21N:R90W (a few miles south of I-80) southward to T15N:R92W. From there southward to T13N:R91W the

coals become discontinuous and spotty in distribution. Both the Red Rim and China Butte coals have high known mineral deposit area (KMDA) values (>$1 million based on 1981 prices). Together they include about 26,234 leasable acres.

Studies of the Fort Union Formation coals in the ARPA and adjacent areas have been conducted by Sanders (1974, 1975), Edson (1979), Honey and Hettinger (1989), Honey and Roberts (1989), and Honey (1990). As many as 10 coals seams have been mapped in the subsurface with individual seams averaging 10 to 20 feet thick, but thickening to as much as 40 feet. Net coal thickness increases in the subsurface southward toward the Baggs area where it may reach a maximum of about 75 feet. Thicker Fort Union coals have been interpreted to have accumulated in flood plains above and on the flanks of major Paleocene age, south to north oriented river systems. Thinner coal seams accumulated away from these main trunk streams.

The Fort Union Formation is a primary coalbed natural gas target in the southeastern Greater Green River Basin, but the formation crops out at the surface only in the western most part of the project area, so few if any of the coal beds which dip westward are buried deep enough to be candidates for development. Deeper buried coal beds east and south of the area have ash free gas contents generally less than 100 scf/ton, but ranging from 9 to 561 scf/ton. Scott et al. (1994) estimated coal gas reserves in the western and southwestern parts of Carbon County, Wyoming, underlying the project area, to be less than 2 bcf/mi^2 near the eastern margins of its subcrop to 6 to 8 bcf/mi^2 in deeper buried areas north and west of Baggs, Wyoming. These values may be enhanced by migration of gasses into the area from deeper parts of the basin. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, Fort Union coals rank as subbituminous high volatile C bituminous and high volatile B bituminous.

Lance Formation

Coals occur discontinuously in outcrop in the Lance Formation from I-80 south to about T15N. Averaging about 5 feet in thickness, but ranging from a few inches to 22 feet thick, coals are thicker, more abundant, and laterally extensive in the lower part of the formation. The coals have limited lateral extent and usually cannot be traced more than a few hundred to several thousand feet. Lance Formation coal beds are minor coalbed natural gas targets (Scott et al. 1994).

Mesaverde Group

Coals occur in outcrops in the Mesaverde Group in several places along the western edge of the Sierra Madre. These are best developed high in the Mesaverde Group near its contact with the overlying Lewis Shale in exposures along the eastern edge of the ARPA (Atlantic Rim and Green River Coal Fields) and in T15-16N:R90-91W (an unnamed coal field). These fields have moderate KMDA value (less than $1 million, based on 1981 prices) and include about 230,400 leasable acres. Coals are also developed sporadically lower in the Mesaverde Group (Allen Ridge Sandstone), but these coals are thin and discontinuous, and areas containing them are rated as having a low KMDA value. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, the Mesaverde coals underlying the ARPA rank as high volatile C bituminous, high volatile B bituminous and high volatile A bituminous.

Coals in the Ericson Sandstone (=Pine Ridge Sandstone or Williams Fork Formation) include the thickest and most extensive coals of the Upper Cretaceous in the Greater Green River Basin and are the basin's prime CBNG targets. The maximum net coal thickness of about 220

feet, contained in 40 individual coal beds, occurs near Craig, Colorado. The coal beds thin in a westerly and northerly direction, so that in the southeastern part of Carbon County, underlying the ARPA, net coal thicknesses range from 40 to 90 feet (12 to 18m). These coals are interpreted to have accumulated in coastal plain environments and fluvial dominated, wave modified deltas, along a southwest-northeast oriented strand (beach) line that faced southeastward into the Cretaceous epicontinental seaway. Three depositional coal cycles are represented that accumulated in response to progradation as a result of sea level drop or changes in delta location, or both. The thickest coals in these cycles overlie shoreline sandstones with thinner and less continuous coals developed between deltaic distributary channel sandstones.

Gas content values for coals developed in the Ericson Sandstone (=Pine Ridge Sandstone or Williams Fork Formation) range from less than 1 to more than 540 scf/ton, but are generally less than 200 scf/ton. Samples from the Sand Wash Basin indicate a gradual increase in gas content with increasing burial, but that coal rank does not increase significantly with depth. Gas contents of samples taken shallower than 1,000 feet are less than 20 scf/ton suggesting that coalbed gases may have migrated out of the system because either confining pressures were low, the over-lying seals were absent, or both. Analysis of 36 coal samples from six wells provided a gas dryness range from 0.79 to 1.0 with an average of 0.95; carbon dioxide content of less than 1 to more than 25%, with an average of 6.7%; and a nitrogen content of less than 1 to 20% with an average of 4%. Coals having a high carbon dioxide content are characterized by high C1-C1-5 values.

Based on gas content values, Scott et al. (1994) estimated coal gas reserves in the western and southwestern parts of Carbon County, Wyoming, underlying the ARPA, to be less than or equal to 10 bcf/mi^2 near the eastern margins of its subcrop and 8 to 40 bcf/mi^2 in the extreme southwestern corner of the county.

Coals in the Rock Springs Formation (Allen Ridge Sandstone or Iles Formation) are thinner and not as well developed as those in the Pine Ridge and the formation is considered a minor coal-bearing unit and CBNG target. A maximum net coal thickness of 32 feet occurs in the easternmost part of the Great Divide Basin, but most other places it is typically less than 15 feet. These coals are interpreted to have accumulated in a variety of swampy environments above shoreline sandstones and in flood plains adjacent to delta river channels.

Based on samples from wells primarily in the Rock Springs Uplift, gas content values in the Rock Springs Formation (= Allen Ridge Sandstone or Iles Formation) range from 0 to more than 650 scf/ton. No estimates of total coal gas reserves are available for this unit.

Oil and Gas

The ARPA and adjacent areas to the west have produced significant quantities of oil and natural gas. Production is chiefly from Cretaceous geologic units including the Mesaverde Group, Steele Shale, Niobrara Shale, Frontier Formation, Muddy Sandstone, and Cloverly Formation. In addition, Jurassic rocks of the Morrison Formation, Triassic rocks of the Chugwater Formation, and Pennsylvanian rocks of the Tensleep Sandstone have proved productive. Oil and gas fields of interest (The Oil and Gas Fields Symposium committee 1957 1979, 1992, Gregory and DeBruin 1991, DeBruin and Boyd 1991, DeBruin 1996, Cronoble 1969, DeBruin 1993, Kaiser et al. 1994) include the Baldy Butte (T17N:R92W), Browning (T14N:R91W), Browns Hill (T16N:R90-91W), Cherokee Creek (T15N:R91W), Cow Creek (T16N:R92W), Deep Creek (T16N:R90-91W), Deep Gulch (T16N:R91W), Dixon (T12-13N:R90W), Espy

(T19N:R89W), Sierra Madre (T13N:R89-90W), and Sugar Creek (T19N:R90W). Oil and gas are produced from combined stratigraphic and faulted structural (anticlinal) traps.

3.1.3 Paleontologic Resources

Known paleontologic resources within sedimentary deposits in the project area record the history of animal and plant life in Wyoming during the early part of the Cenozoic Era (Paleocene and Eocene Epochs) and latest part of the Mesozoic (Cretaceous Period) Era. Potential fossil resources could extend this record into the late Cretaceous Period and middle Cenozoic Era (Miocene).

As described above, mapping documents eight geologic deposits exposed at the surface in the project area. These include, from youngest to oldest: (1) unnamed deposits of Quaternary (Holocene to Pleistocene) age, (2) Browns Park Formation of Miocene age, (3) Wasatch Formation of early Eocene age, (4) Fort Union Formation of Paleocene age, (5) Lance Formation of Latest Cretaceous age, (6) Fox Hills Sandstone of latest Cretaceous age, (7) Lewis Shale of Latest Cretaceous age, and (8) Mesaverde Group of Late Cretaceous age.

With the exception of the Holocene deposits that are probably too young to contain fossils, all sedimentary rock units exposed in the project area are known to produce or have the potential to produce scientifically significant vertebrate fossil resources. Scientifically significant fossil vertebrates have been recovered from the Wasatch (Morris 1954, Honey 1988, Roehler 1972, 1991 a-b, 1992 a-c, 1993, Roehler et al. 1988), Fort Union (Rigby 1980, Winterfeld 1981), and Lance Formations (Dorf 1942, Estes 1964, Clemens 1966, Clemens et al. 1979, Breithaupt 1982 and 1985, Weishample 1992, Archibald 1993, Lillegraven 2002, Honey 2003) within the ARPA or immediately adjacent areas.

Specifically, 15 fossil vertebrate localities are known to occur within the ARPA in the Lance Formation and 17 fossil vertebrate localities are known to occur within the Fort Union Formation. The Lance Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T18N:R20W), Doty Mountain (T17N:R91-92W), Peach Orchard Flat (T15N:R91W) and Blue Gap (T15N:R91W) 7.5 minute Quadrangles. The Fort Union Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T19N:R91W), Duck Lake (T16-17N:R91-91W), Mexican Flats (T16N:R92W) and Blue Gap (T15-16N:R91-92W) 7.5 minute Quadrangles. Localities from both the Lance and Fort Union Formations produce a wide variety of fossil vertebrate remains, including those of mammals, reptiles, amphibians, and fish. Of great importance is the occurrence within the Fort Union Formation of some of the oldest known Paleocene age fossil vertebrates in the world, which are considered to be of Puercan age, and are very rare (Honey 2003).

Vertebrate fossils of scientific significance have also been found in deposits of the Browns Park Formation (McGrew 1951 and 1976, Bradley 1964, Montagne 1991), and Mesaverde Group (Breithaupt 1985, Case 1987, Clemens and Lillegraven 1986, Lillegraven and McKenna 1986) in other areas of Wyoming and Colorado, but not within the ARPA. Vertebrate fossils of limited significance have been identified in the Fox Hills and Lewis Shale exposed on the Rocks Springs Uplift (Winterfeld 1978, Breithaupt 1985). Information on the geologic deposits exposed in the project area and the BLM Paleontologic Condition they satisfy are summarized in Table 3-2.

3.2 CLIMATE AND AIR QUALITY

3.2.1 Climate

The Atlantic Rim Project Area is located in a semiarid (dry and cold), mid-continental climate regime. The area is typified by dry, windy conditions, with limited rainfall and long, cold winters. The nearest meteorological measurements were collected at Baggs, Wyoming (1979-2000), approximately 3 miles southwest of the project area at an elevation of 6,240 ft (WRCC 2003). Because of the wide variation in elevation and topography within the study area, site-specific climatic conditions vary considerably.

The annual average total precipitation at Baggs is 10.7 inches, ranging from 18.5 inches (1983) to 4.6 inches (1989). Precipitation is evenly distributed throughout the year, with minor peaks in May, July, and October. An average of 38.8 inches of snow falls during the year (annual high 104.0 inches in 1983), with December and January the snowiest months. Table 3-3 shows the mean monthly temperature ranges and total precipitation amounts.

The Baggs region has cool temperatures with average daily temperatures (in degrees Fahrenheit; °F) ranging between 3 °F (low) and 33 °F (high) in mid winter and between 56 °F (low) and 75 °F (high) in mid summer. Extreme temperatures have ranged from –50 °F to 100 °F (both occurring in 1984). The frost-free period (at 32 °F) generally occurs from mid-May to mid-September.

Table 3-3. Mean Monthly Temperature Ranges and Total Precipitation Amounts.

Month	Average Temperature Range (°F)	Total Precipitation (inches)
January	5-33	0.56
February	9-36	0.43
March	20-47	0.44
April	28-59	0.82
May	34-68	1.52
June	41-79	0.89
July	48-86	1.33
August	46-84	0.99
September	38-74	1.14
October	27-61	1.33
November	16-43	0.66
December	7-34	0.54
ANNUAL	42.6 (mean)	10.71 (mean)

Source: (WRCC 2003)

The project area is subject to strong and gusty winds, reflecting channeling and mountain valley flows due to complex terrain. During the winter months strong winds are often accompanied by snow, producing blizzard conditions and drifting snow. The closest comprehensive wind measurements are collected at the Rawlins, Wyoming, airport nearly 60 miles north-northeast of the project area. However, hourly wind data measurements for December 1994 through November 1995 were collected near Baggs, Wyoming during the Mount Zirkel Wilderness Area

Visibility Study. Due to the proximity to the project area, these data (rather than the more distant Rawlins wind data) were used to describe the wind flow patterns in the region. Figure 3-1 shows the relative frequency of winds, with radial distributions by speed class, indicating the direction of the wind source. Table 3-4 provides the wind direction distribution in a tabular format. From this information, it is evident that the winds originate from the south to southwest nearly 37 percent of the time. The annual mean wind speed is nearly 10 mph.

Table 3-4. Wind Direction Frequency Distribution for Baggs, WY.

Wind Direction	Percent of Occurrence
N	5.2
NNE	3.8
NE	2.7
ENE	3.8
E	4.8
ESE	8.9
SE	6.9
SSE	7.6
S	13.8
SSW	13.4
SW	10.0
WSW	5.1
W	4.4
WNW	4.0
NW	2.6
NNW	3.1

Source: South Baggs meteorological data collected December 1994 - November 1995.

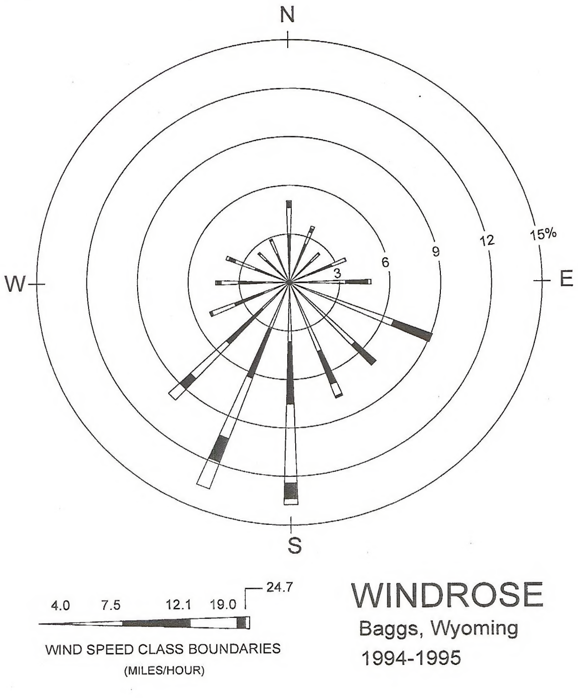
The frequency and strength of the winds greatly affect the dispersion and transport of air pollutants. Because of the strong winds in the project area, the potential for atmospheric dispersion is relatively high (although nighttime cooling would enhance stable air, inhibiting air pollutant mixing and transport). Dispersion conditions would be the greatest to the north and along the ridge and mountain tops.

Table 3-5 shows the frequency distribution of wind speed and atmospheric stability class. The atmospheric stability class is the measure of atmospheric turbulence, which directly affects pollutant dispersion. The stability classes are divided into six categories designated "A" (unstable) through "F" (very stable). The "D" (neutral) stability class occurs more than half of the time.

Table 3-5. Wind Speed and Stability Class Distribution.

Wind Speed (miles/hour)	Percent of Occurrence	Stability Class	Percent of Occurrence
0-4.0	6.4	A (unstable)	6.0
4.0-7.5	33.0	B	8.2
7.5-12.1	29.8	C	14.8
12.1-19.0	21.7	D (neutral)	56.6
19.0-24.7	5.4	E	9.9
Greater than 24.7	3.7	F (very stable)	4.5

Source: South Baggs meteorological data collected December 1994 - November 1995.



NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE OF EACH WIND DIRECTION.
WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING.
EXAMPLE - WIND IS BLOWING FROM THE NORTH 5.1 PERCENT OF THE TIME.

Source: South Baggs meteorological data collected December 1994 - November 1995.

Figure 3-1. Wind Rose for the Atlantic Rim Natural Gas Project Area.

3.2.2 Air Quality

The Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS) are health-based criteria for the maximum acceptable concentrations of air pollutants at all locations to which the public has access. Although specific air quality monitoring has not been conducted within the project area, regional air quality monitoring has been conducted within the cumulative study area. Air pollutants measured in the region for which ambient air quality standards exist include: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns in effective diameter (PM_{10}), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), and sulfur dioxide (SO_2). Background pollutant concentrations for these pollutants are compared to the WAAQS and NAAQS in Table 3-6.

As shown in Table 3-6, regional background values are well below established standards, and all areas within the cumulative study area are designated as attainment for all criteria pollutants. Background air quality concentrations are combined with modeled project-related air quality impacts of the same averaging time periods, and the total predicted impacts are compared to applicable air quality standards.

Federal air quality regulations adopted and enforced by WDEQ-AQD limit incremental emissions increases to specific levels defined by the classification of air quality in an area. The Prevention of Significant Deterioration (PSD) Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. The incremental increase depends upon the area's classification. Four PSD Class I areas are identified as sensitive areas within the cumulative impact assessment area: the Bridger, Fitzpatrick, Mount Zirkel and Rawah Wilderness Areas. Strict limitations on the additional amount of air pollution allowed from major emitting facilities in PSD Class I areas are applied. These limitations are quantified as Class I PSD Increments, which are compared to impacts from cumulative regional sources, and Proposed Class I PSD Significance Levels, which are compared to impacts from individual emission sources to determine their singular significance. The remainder of the cumulative impact assessment area is classified PSD Class II, where similar but less stringent incremental air quality limits apply. The Popo Agie and Savage Run Wilderness Areas, Dinosaur National Monument, and the Wind River Roadless Area are PSD Class II areas, which have been identified as sensitive areas within the cumulative study area. PSD Class I and Class II Areas are shown in Appendix M. Regional background pollutant concentrations, as well as NAAQS, WAAQS, and PSD Class II Increments, are presented in Table 3-6.

All NEPA analysis comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis. The determination of PSD increment consumption is an air quality regulatory agency responsibility. Such an analysis would be conducted as part of the New Source Review process for a major source, as would an evaluation of potential impacts to Air Quality Related Values (AQRV) such as visibility, aquatic ecosystems, flora, fauna, etc. performed under the direction of WDEQ-AQD in consultation with Federal Land Managers, or would be conducted to determine minor source increment consumption.

Table 3-6. Air Pollutant Background Concentrations, Wyoming and National Ambient Air Quality Standards, and Prevention of Significant Deterioration (PSD) Increments (µg/m³).

Pollutant/Averaging Time	Measured Background Concentration	Wyoming and National Ambient Air Quality Standards	Incremental Increase Above Legal Baseline PSD Class I	PSD Class II
Carbon Monoxide (CO) [1]				
1-hour	3,336	40,000	n/a	n/a
8-hour	1,381	10,000	n/a	n/a
Nitrogen dioxide (NO_2) [2]				
Annual	3.4	100	2.5	25
Ozone [3]				
1-hour	169	235	n/a	n/a
8-hour	147	157		
Particulate Matter (PM_{10}) [4]				
24-Hour	47	150	8	30
Annual	16	50	4	17
Particulate Matter ($PM_{2.5}$) [4]				
24-Hour	15	65	n/a	n/a
Annual	5	15	n/a	n/a
Sulfur dioxide (SO_2) [5]				
3-hour (National)	132	1,300	25	512
24-hour (National)	43	365	5	91
24-hour (Wyoming)	43	260	5	91
Annual (National)	9	80	2	20
Annual (Wyoming)	9	60	2	20

[1] Background data collected by Amoco at Ryckman Creek for an 8-month period during 1978-1979, summarized in the Riley Ridge EIS (BLM 1983).

[2] Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (ARS 2002).

[3] Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002).

[4] Background data collected by WDEQ-AQD at Emerson Building, Cheyenne, Wyoming, Year 2002. These data have been determined by WDEQ-AQD to be the most representative co-located PM_{10} and $PM_{2.5}$ data available.

[5] Background data collected at LaBarge Study Area for the Northwest Pipeline Craven Creek Site 1982-1983.

There are two types of visible impairment caused by emission sources, plume impairment and regional haze. Plume impairment occurs when a section of the atmosphere becomes visible due to the contrast or color difference between a discrete pollutant plume and a viewed background such as a landscape feature. Regional haze occurs when pollutants from more diffuse emission sources become well mixed in the atmosphere causing a general alteration in the appearance of landscape features, changing the color or contrast between the landscape features or causing features of a view to disappear. Plume impairment calculations, which consider contrast and color difference, are generally performed when an emissions source is within 50 km of a view whereas impacts of regional haze, or visibility impairment, are considered at 50 km and beyond.

Visibility impairment is often referred to in terms of either atmospheric light extinction coefficient or visual range. Atmospheric light extinction is the sum of light scattering due to scattering and absorption by gases and particles in the atmosphere. Visibility impairment is measured in terms of change in light extinction or change in deciview (dv). A dv change of 1 to 2 (equivalent to a 10% to 20% change in extinction) represents a small but perceptible change in visibility. Visual range, referred to as standard visual range (SVR), is the farthest distance at which an observer can just see a black object viewed against the horizon sky. The higher the SVR, the better the visibility. Visibility within the cumulative study area is considered very good, with an average SVR of over 150 km (Malm 2000). However, the potential for visibility impairment to current conditions at the PSD Class I and Class II Areas identified within the cumulative study area has been identified as a concern.

In 1985 the Interagency Monitoring of PROtected Visual Environments (IMPROVE) monitoring program was initiated to establish current visibility conditions, track changes and establish long–term trends in visibility, and to determine the causal mechanisms of visibility impairment in the National Parks and Wilderness Areas. IMPROVE is a cooperative measurement effort composed of representatives from the EPA, NPS, USDA Forest Service, BLM, U.S. Fish and Wildlife Service (USFWS), and state agencies. The IMPROVE network began with 20 monitoring sites in 1987 and now includes over 140 sites representing Class I parks and wilderness areas across the nation

Within the cumulative study area there are currently four IMPROVE visibility monitoring sites, the Bridger Wilderness Area and Brooklyn Lake sites in Wyoming and the Mount Zirkel Wilderness Area and Rocky Mountain National Park sites in Colorado. Table 3-7 provides 2001 baseline visibility conditions monitored at these four sites (CIRA 2003).

Table 3-7. 2001 Standard Visual Range Data.

Site	*Standard Visual Range (km)*	
	Average Condition	20th Percent Cleanest Days
Bridger Wilderness Area	181	272
Brooklyn Lake	184	283
Mount Zirkel Wilderness Area	175	249
Rocky Mountain National Park	154	275

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and it is reported as the mass of material deposited on an area per year (kilograms per hectare per year). Air pollutants are deposited by wet deposition (precipitation) and dry deposition (gravitational settling of pollutants). Background wet and dry atmospheric acid deposition impacts have been monitored at the National Acid Deposition Program (NADP) National Trends Network (NTN) and Clean Air Status and Trends Network (CASTNET) stations near Pinedale and Centennial/Brooklyn Lake, Wyoming. Total deposition (wet and dry) reported as total sulfur and total nitrogen deposition for Pinedale, 2003 and Centennial/Brooklyn Lake, 2002 are provided in Table 3-8.

Table 3-8. 2001 Measured Acid Deposition Data (kg/ha-yr).

Site Location	Nitrogen Deposition	Sulfur Deposition
Pinedale	1.4	0.65
Centennial/Brooklyn Lake	2.7	0.84

Total deposition levels of concern (LOC) have been estimated for several areas, including the Bridger Wilderness Area (USDA-FS 1989). The "red line" LOC is defined as the total deposition that the area can tolerate, and the "green line" LOC is defined as the acceptable level of total deposition. Cumulative impacts plus background are compared to these LOCs. The Bridger Wilderness nitrogen deposition red line LOC is 10 kg/ha-yr and nitrogen deposition green line LOC is 3-5 kg/ha-yr. The Bridger Wilderness sulfur deposition red line LOC is 20 kg/ha-yr and sulfur deposition green line is 5 kg/ha-yr.

Site-specific lake chemistry background data (pH, acid neutralizing capacity, elemental concentrations, etc.) have been collected by the U.S. Geological Survey (Water Quality Division) in several high mountain lakes in the nearby Wilderness Areas. Lakes for which background data were collected are shown in Appendix M: PSD Class I and Class II Sensitive Areas and Sensitive Lakes. Lake acidification is measured in terms of change in acid neutralizing capacity (ANC), which is the lake's buffering capacity to resist acidification from atmospheric deposition of acid compounds such as sulfates and nitrates. Measured baseline ANC data for sensitive lakes within the cumulative study domain are provided in Table 3-9.

Lakes with ANC values ranging from 25 to 100 microequivalents per liter (µeq/l) are considered to be sensitive to atmospheric deposition, lakes with ANC values ranging from 10 to 25 µeq/l are considered very sensitive, and lakes with ANC values less than 10 µeq/l are considered extremely sensitive.

The USDA Forest Service has identified specific AQRV "Level of Acceptable Change" (LAC) values which are used to evaluate potential air quality impacts from deposition within their wilderness areas (USDA-FS 2000). The USDA Forest Service has identified a LAC of no greater than 1 (µeq/l) change in ANC (from human causes) for lakes with existing ANC levels less than 25 µeq/l. A limit of 10 percent change in ANC reduction was adopted for lakes with existing ANC greater than 25 µeq/l.

Table 3-9. Background ANC Values for Acid Sensitive Lakes.

Wilderness Area	Lake	Latitude (Deg-Min-Sec)	Longitude (Deg/Min-Sec)	10th Percentile Lowest ANC Value[1] (µeq/l)	Number of Samples	Monitoring Period
Bridger	Black Joe	42°44'22"	109°10'16"	67.0	61	1984-2003
Bridger	Deep	42°43'10"	109°10'16"	59.9	58	1983-2003
Bridger	Hobbs	43°02'08"	109°40'20"	59.9	65	1983-2003
Bridger	Lazy Boy	43°19'57"	109°43'47"	18.8	1	1997
Bridger	Upper Frozen	42°41'13"	109°09'39"	5.0	6	1997-2003
Fitzpatrick	Ross Lake	43°22'41"	109°39'30"	53.5	44	1988-2003
(GLEES)	West Glacier Lake	41°22'38"	106°15'31"	35.2	14	1988-1996
Mount Zirkel	Lake Elbert	40°38'3"	106°42'25"	51.9	55	1988-2003
Mount Zirkel	Seven Lakes	40°53'45"	106°40'55"	36.2	55	1985-2003
Mount Zirkel	Summit Lake	40°32'43"	106°40'55"	47.3	95	1985-2003
Popo Agie	Lower Saddlebag	42°37'24"	108°59'38"	55.5	43	1989-2003
Rawah	Island Lake	40°37'38"	105°56'26"	68.7	15	1996-2002
Rawah	Kelly Lake	40°37'32"	105°57'34"	181.1	13	1995-2002
Rawah	Rawah #4 Lake	40°40'16"	105°57'28"	41.2	13	1996-2002

[1] 10th Percentile Lowest ANC Values reported

3.3 SOILS

3.3.1 Introduction

Vegetation type, growth form, composition, distribution, and density in the ARPA are principally governed by the biological, chemical, and physical properties of the parent soil and precipitation régime. The complex relationship of these two essential natural resources ultimately controls habitat quantity and quality for the fauna and flora of Wyoming.

Parent materials in the ARPA include the marine sandstones and shales of the Lewis Formation (Upper Cretaceous), the largely fluvial conglomerates, sandstones, mudstones, shales and

coals of the Lance Formation (Upper Cretaceous) and Fort Union Formation (Paleocene), the fluvial sandstones and variegated mudstones of the Wasatch Formation (Eocene), and the conglomerates, sandstones, and volcaniclastic mudstones of the Brown's Park Formation (Miocene). Slopewash debris and alluvium derived from those units also constitute parent materials for colluvial and alluvial soils. A large area known as the "Sand Hills" (series of Holocene-age sand dunes) occurs in the central part of the ARPA.

The ARPA is typical of a desert intermontane basin with physiography dominated by: (1) hogbacks and strike valleys, (2) flat-topped stripped bedrock surfaces (strath terraces), (3) pebble/gravel/cobble stream terraces, (4) alluvial fan deposits, and (5) alluvium along the principal drainages.

Surface elevations within the ARPA range from 8,294 feet (2,529m) in Sec. 13, T18N:R90W, to about 6,500 feet (1,982m). Several Mesaverde Formation hogbacks above Separation and Jep Canyon reach elevations exceeding 8,000 feet (2,438m). Prominent landmarks include Cow Creek Butte (7,929 feet/2,417m) developed in the Brown's Park Formation (NE1/4 Sec. 15, T16N:R90W) and Muddy Mountain (7,904 feet/2,409m), developed on a Lance Formation hogback (NE1/4 Sec. 8, T13N:R90W). The lowest point (6,420 feet/1,957m) occurs on Peach Orchard Flat in the flood plain alluvium of Muddy Creek (Sec. 31, T15N:R91W).

Slopes within the project area are generally level to undulating (0 to 10 percent), broken by areas of steeper (10 to 40 percent) and very steep slope to vertical faces (rock outcrops).

Maximum slope over a three-mile intersect is about 7% grade (1,100 feet rise in 15,840 ground feet in the S1/2 T18N:R90W) and the minimum slope nears 0% grade in the NE ¼ T16N:R92W, and at a few other sites.

3.3.2 Project Area Soils

Texas Resource Consultants (TRC)(1981) and Wells *et al.* (1981) surveyed and described the dominant soil series, associations, and complexes encompassed within the project area at a third order level of detail. Each of these soil survey efforts was conducted for the BLM, in cooperation with the NRCS, then Soil Conservation Service (SCS). Interpretation ratings were developed for each map unit based upon the "Soil 5" filled out for the soil series which were based upon standards and procedures of the SCS National Soils Handbook, the SCS Guide for Interpreting Engineering Uses of Soils, the PCA Soils Primer, and Wischmeier and Smith (1978). Some areas are not mapped currently, which cover 8,634 acres or 3% of the Project Area.

According to the soil surveys, a total of 152 soil Complexes, Associations, Taxadjuncts, and Variant map units occur within the ARPA. A total of 96 soil series, in various degrees of composition, comprise the 152 map units. For these soils, soil depth ranges from shallow to deep, soil drainage from somewhat poor to somewhat excessive, permeability ranges from slow to rapid, water capacity ranges from very low to high, runoff from slow to rapid, and susceptibility to water and wind erosion ranges from slight to very severe. Basically, the soils are highly variable across this broad area.

3.3.3 Project Area Soil Limitations

Project area soil properties and limitations are discussed below. The topsoil category of poor and fair with "excess salt" as rationale (41,215 acres) provides good indication where potential

reclamation problems may occur (Appendix M: Topsoils with Excess Salts). Severe wind and water erosion from these excess salt soils may increase the total salt load to the individual watershed and eventually to the Upper Colorado River System. A soil with a moderate or severe limitation or a fair or poor suitability does not mean the soil can not be used for a particular use. It does mean that if the soil is used, it may be more costly and difficult to accomplish the particular use.

Table 3-10 summarizes the data for these five categories and their individual ranking criteria for the contiguous ARPA. Table 3-11 shows these five categories as they relate to each of the twenty-one 6th level HUCs. Four of the five categories of concern are color-coded orange for three HUCs indicating that a high level of attention for any project-related activities within these HUCs is warranted. Eleven HUCs are ranked with three orange categories and eight deserve the same high attention because of size and overlapping sensitivities. None of the 21 HUCs have all categories in the green range.

Soil Texture and Strength

Clay and sandy soils have low strength under load and present severe limitations on road placement, construction, and maintenance (Appendix M: Soils with Severe Road Rating). A limitation is also placed on structure location and construction. Low-strength soils account for about 234,755 acres within the project area, or about 87% of the total land surface area of the ARPA.

Shallow soils and very shallow soils comprise about 33,700 acres within the project area. These present difficulty in reclamation pipeline placement. About 45,445 acres (Good topsoil ranking) have moderate permeability.

Soil Salinity and Sodicity

Most of the soil series in the ARPA overlay alkaline sub-soils which affects germination, plant growth, and species composition.

A biological source that exacerbates this problem is the recent invasion and establishment of halogeton (*Halogeton glomeratus*) in the ARPA and surrounding areas. Halogeton, an annual plant, is an aggressive invader of newly disturbed sites with alkaline to saline soils. Plant tissues accumulate salts from lower soil horizons. The salts leach from dead plant material, increasing topsoil salinity and favoring halogeton seed germination and establishment.

Erosion Potential

Soils with severe water erosion potential (high in clay content or are shallow over bedrock) exist on 64,260 acres within the ARPA. This figure increases by 13,328 acres when the moderate to severe rating is added and 148,918 acres when the slight to severe rating is added.

Soils with severe wind erosion potential (soils with sandy surface textures) encompass about 5,674 acres. However, this increases by about 17,000 acres if the moderate to severe rating is added. These soils can be difficult to reclaim and stabilize once disturbed.

Soils with high runoff potential (high in clay content, slopes, or shallow over bedrock) exist on 105,156 acres within the ARPA (Appendix M: Soils with High Runoff Potential). This figure

increases to 197,418 acres when the moderate to high rating is added. These soils can also be difficult to reclaim and stabilize once disturbed. These soils contribute to sediment and salt loading into the watersheds.

Reclamation Potential

Reclamation potential is predominantly poor to fair in the ARPA. Poor and fair topsoils occupy approximately 210,992 acres, or 79% of the total land surface area of the ARPA (Appendix M: Soils with Poor/Fair Topsoil Ratings). High clay content soils occur on about 158,833 acres (61%) and saline soils on about 41,215 acres (16%). In these areas, successful revegetation may require additional efforts to meet BLM reclamation guidelines and time requirements.

3.3.4 Biological Soils Crusts

In general, biological soil crusts are poorly developed or absent within the ARPA. The most common crust component observed is the ground lichen, *Xanthoparmelia chlorochroa*, commonly called Parmelia.

3.3.5 Existing Soil Disturbances

Chapter 2 discusses the amount and nature of existing disturbances within the ARPA. Briefly, existing project-related disturbances to the soil resource includes about 600 acres, or 0.2% of the total land surface area of the ARPA. The majority of this total is 315 acres attributed to 210 gas well sites. Existing roads account for about 247 acres; compressor stations, 13 acres; transfer pumping stations, 1.0 acre; containment ponds, 25 acres; and deep injection well sites, 4 acres.

Table 3-10 Total Area (acres) of Soil Factors of Concern within the ARPA.[A]

Factor	Category	Acres[B]	% Total Area[B]
Water Erosion	No Data	8,171	3.2
	Slight	17,534	6.7
	Slight to Moderate	9,336	3.6
	Slight to Severe	148,918	56.9
	Moderate to Severe	13,328	5.1
	Severe	64,260	24.6
Wind Erosion	No Data	8,171	3.2
	Slight	23,427	9.0
	Slight to Moderate	82,771	31.7
	Moderate	124,523	47.7
	Moderate to Severe	16,982	6.5
	Severe	5,674	2.2
Runoff Potential	No Data	9,465	3.7
	Low	4,422	1.7
	Low to Moderate	3,567	1.4
	Low to High	12,930	5.0
	Moderate	33,744	12.9
	Moderate to High	92,262	35.3
	High	105,156	40.2
Topsoil Rating	No Data	5,111	2.0
	Poor	88,971	34.1
	Fair	122,021	46.7
	Good	45,445	17.4
Topsoil Rationale (Poor and Fair)	No Data	5,111	2.0
	Excess Salt	41,215	15.8
	Large Stones	6,512	2.5
	Too Clayey	158,833	60.8
	Too Sandy	2,574	1.0
	Wet	1,859	0.8
Road Rating	No Data	5,111	2.0
	Moderate	177,331	67.8
	Moderate to Severe	1,937	0.8
	Severe	77,169	29.5
Road Rationale	No Data	5,111	2.0
	Depth to Bedrock	17,736	6.8
	Low Strength	234,755	89.8
	Shrink-Swell Clays	58	0.1
	Too Sandy	2,438	1.0
	Wet	1,450.7	0.6

[A] Based on BLM analysis of soil survey data provided by Texas Resource Consultants (1981) and Wells et al. (1981).
[B] Acreage and percent total acres calculated on available soils data (261,550 acres) within the 270,180 acre project area.

Table 3-11. Total Area of Soil Factors of Concern by Sub-watersheds within the Atlantic Rim Project Area.[A]

HUC Name	Total Area Of HUC in ARPA (Ac.)	Water Erosion (Slight/Severe Moderate/Severe Severe)	Wind Erosion (Moderate/Severe Severe)	Runoff Potential (Low/High Moderate/High High)	Topsoil Rating (Poor)	Road Rating (Moderate/Severe Severe)
1. Dry Cow Creek	39,997	35,168	6,603	33,809	35,277	15,373
2. Cow Creek	25,027	18,650	470	17,097	16,071	5,056
3. Muddy Creek-Alamosa Gulch	21,439	19,102	1,723	19,702	13,517	3,420
4. Cherokee Creek	22,806	21,137	32	17,309	19,197	10,266
5. Deep Creek	22,791	21,329	0	18,760	19,206	13,575
6. Wild Cow Creek	21,060	15,682	354	13,758	14,746	8,599
7. Little Snake River-Cottonwood Creek	17,422	16,350	68	14,071	14,612	5,682
8. Separation Creek-Scotty Canyon	15,722	14,191	1,529	13,364	12,235	3,145
9. Upper Fillmore Creek	13,989	13,051	943	13,044	11,513	571
10. Muddy Creek-Blue Gap Draw	11,419	7,409	404	9,385	9,250	3,499
11. Hadsell Draw	11,158	9,747	1,443	9,972	8,418	656
12. Muddy Creek-Coal Mine Draw	8,871	7,296	581	7,988	7,230	447
13. Upper Sugar Creek	8,028	3,122	13	2,648	4,731	439
14. Little Snake River-Dutch Joe Creek	7,489	7,040	0	6,906	5,860	304
15. Muddy Creek-Antelope Creek	7,429	5,646	262	6,078	5,702	2,759
16. Muddy Creek-Robber's Gulch	7,162	5,355	0	5,384	5,085	1,523
17. Separation Creek-Red Rim	3,818	2,089	568	3,542	3,378	1,998
18. Lower Savery Creek	2,468	2,608	0	2,285	2,468	1,795
19. Bird Gulch	2,073	2,073	0	86	2,073	0
20. Lower Barrel Springs Draw	9	6	0	6	0	0
21. Middle Savery Creek	5	5	0	0	5	0
Totals	**270,182**	**227,056**	**14,993**	**215,197**	**210,574**	**79,107**

[A] Color code based on proportion (%) of the total area of each HUC that the category of concern represents. Arbitrary classification is: **GREEN** 0-20%, **YELLOW** 21-50%, **ORANGE** 51-100%.

3.4 WATER RESOURCES

Surface waters include resources in three major drainage basins: the Colorado River Basin, the Missouri River Basin, and the Great Divide Basin. The project area is predominantly within the Colorado River Basin (~75%) and drained by the intermittent Muddy Creek, a tributary of the Little Snake River. Within the ARPA, Muddy Creek's named tributaries, which are ephemeral, include Deep Creek, Cherokee Creek, Wild Cow Creek, and Cow Creek (and its named tributaries Dry Cow Creek and Deep Gulch), as well as its unnamed ephemeral tributaries. Some minor unnamed and named ephemeral tributaries of the Little Snake River (i.e., Cottonwood Creek and Dutch Joe Creek) drain the southern-most portion of the ARPA. A portion of the project area is also drained into the Savory Creek drainage, a main tributary to the Little Snake. A small part of the northeastern portion of the ARPA is in the upper portion of Sugar Creek an ephemeral stream within the Missouri River Basin. Separation Creek, a named ephemeral stream within the Great Divide Basin, and Filmore Creek drains the northwestern portion of the ARPA. There are a number of named and unnamed seeps and springs, as well as numerous man-made ephemeral and intermittent livestock reservoirs and ponds. The perennial Little Snake River is the most important surface water resource in the general vicinity and falls immediately outside of the southern boundary of the project area. The Little Snake River is part of the Yampa-White river system within the Colorado River Basin, Muddy Creek joins the Little Snake just above Baggs Wyoming. The Yampa-White river system is important for native fish recovery programs for the humpback chub, bonytail, Colorado pikeminnow, and razorback sucker. The Colorado River is probably one of the most utilized river systems in the west with innumerable municipal, industrial, and agricultural uses.

Groundwater resources include deep and shallow, confined (artesian) and unconfined (water table) aquifers. The unconfined aquifers are generally shallow, "blanket" type deposits of Quaternary or Tertiary age and are generally found 400 – 600 ft. below the ground surface. Alluvial and glacial gravel deposits fall into this category. Artesian aquifers are confined by relatively impermeable rocks and are generally in the deeper formations, such as the Mesa Verde. Water in an artesian aquifer is under hydraulic pressure and will rise above the top of the aquifer. A well tapping an artesian aquifer will flow at the surface provided the hydraulic pressure is sufficient. Most of the geologic formations of pre-Oligocene age in the area contain water under artesian pressure (Welder and McGreevy 1966).

3.4.1 Climate and Precipitation

Meteorological data from Western Regional Climate Center (WRCC) for the Rawlins (No. 487533), Baggs (No. 480484), Dixon (No. 482610), and Wamsutter (No. 489459) weather stations are all relevant to the characterization of water resources in the Atlantic Rim Project Area. Due to the size of the project area and the wide variation in elevation and topography within the study area, site-specific climatic conditions vary considerably. Atlantic Rim at 7,000 to 8,500 ft in elevation forms a portion of the Continental Divide and is the most significant topographic feature within the project area. The northern portion of the ARPA is within the Great Divide Basin, which is approximately 3,815 square miles in area (or 3.9 percent of the land area in the state of Wyoming), and the climate within this internally drained basin is more arid than the balance of the project area. The Continental Divide splits east to west around the Great Divide Basin making it one of the highest and largest closed basins in the world.

The period of record for the Rawlins station (elevation of 6,740 feet) is 1951 to 2005. The period of record for the Baggs station (elevation of 6,240 feet) is 1979 to 2005. The Dixon station (elevation of 6,370 feet) has a period of record from 1922 to 1978, while the Wamsutter

station (elevation of 6,820 feet) has a period of record from 1948 to 2004. The closest comprehensive recording weather station is at the Rawlins airport; located approximately 9 miles northeast of the northeastern corner of the project area. The Baggs station is located approximately three miles southwest of the southwestern corner of the project area, the Dixon station is located approximately two miles south of the southern edge of the project area, and the Wamsutter station is located approximately 25 miles to the northwest of the project area. The locations of Rawlins, Baggs, and Wamsutter, Wyoming relative to the ARPA are shown on Appendix M: Area Map.

Climate. The Atlantic Rim Project Area is located in a continental dry, cold-temperature-boreal climate (Trewartha 1968). This climate is characterized by a deficiency of precipitation (i.e., evaporation exceeds precipitation), and generally has cold temperatures where fewer than eight months of the year have an average temperature greater than 50° F, with warm summer days, cool summer nights, and bitterly cold winters. Strong and prolonged winds periodically sweep the project area throughout the year, being especially prevalent in winter. The project area is typically cool, having an average annual minimum temperature ranging between 26° F and 31° F, an average annual maximum temperature ranging from 55° F to 59° F, and an average annual temperature of about 42° F. The frost-free period (at or above 32° F throughout the day) generally occurs from mid-May to mid-September.

Precipitation. Mean annual precipitation is about 9 -12 inches in the project area depending on elevation. Rawlins and Baggs have an annual average of 9.1 inches and 10.4 inches, respectively. Mean annual precipitation is 10.3 inches at Dixon and 6.8 inches at Wamsutter. Although no long-term data is available for precipitation along the topographically higher Atlantic Rim in the northern portion of the project area, precipitation can be assumed to increase with elevation and has been estimated in the past as 12 inches (HSI, 1981).

Precipitation is somewhat evenly distributed throughout the year with May being the wettest month (1.5 inches at Baggs and 1.3 inches at Rawlins) followed by June, July, and October. January is the driest month (0.5 inches at both Baggs and Rawlins). The majority of precipitation falls as rain from frontal systems and thunderstorms. In regard to intensity of rainfall events, the 50-year, 24-hour precipitation rate ranges from 2.2 inches to 2.6 inches in the project area (Miller et al. 1973). Average total snowfall depth for the year at Baggs and Rawlins is approximately 38 inches and 52 inches, respectively, with the greatest snowfall occurring in December and January (WRCC 2005). Due to the effect of ablation and snow drifting, a discontinuous snow cover is usually present during the winter. Significant accumulation of snow normally occurs at the higher elevations along the Atlantic Rim. Snow drifts in the headwaters of drainages provide critical water storage for shallow springs, streams and stockponds used as water sources in the late summer.

Precipitation in this region varies significantly from year to year. For example, at Rawlins, the month of May has had as little as 0.03 inch and January as much as 1.9 inches of precipitation. The greatest annual precipitation recorded at Rawlins was 12.6 inches in 1998, while the least was 4.9 inches in 1954 (WRCC 2005).

Other Climate Characteristics. Mean annual pan evaporation for this portion of southern Wyoming is about 75 inches, while the mean annual lake evaporation is around 55 inches. The potential annual evapotranspiration is roughly 20 inches (Martner 1986). Compared to the average annual precipitation of 10 inches, this gives an average annual deficit of approximately 10 inches.

The ARPA is subject to frequent winds. The wind is often strong and gusty, reflecting and channeling flows in response to complex terrain. During the winter months, strong winds are often accompanied by snow, producing blizzard conditions and drifting snow. The region experiences extreme wind gusts, especially during thunderstorm activity. Distinct diurnal changes occur, with surface wind speeds generally increasing during the day and decreasing during the night. In the northern portion of the project area, westerly winds dominate the winter climate and are generally due to cold fronts moving over the Interstate 80 corridor, a relatively low portion of the Continental Divide. In the central and southern portion of the project area, winds are generally out of the south or southwest, funneled out of the Little Snake River valley into the Muddy Creek drainage. Violent weather is relatively common in the area; thunderstorms occur an average of 30 days per year and hail an average of three days per year.

These meteorological and climatological characteristics of the project area combine to produce a predominantly dry, cool, and windy climate punctuated by quick, intense precipitation events.

3.4.2 Surface Water Quantity

The Continental Divide splits the ARPA into three major drainage basins. One leg of the Continental Divide runs east and west across the northern portion of the project area. Drainage south of this divide flows south and west to the Little Snake River (Hydrologic Unit Code [HUC] 14050003) in the Colorado River Basin. A second leg of the Continental Divide runs north, dividing the northern portion of the project area. Drainage west of this divide flows north to Separation Lake in the closed Great Divide Basin (HUC 14040200). Drainage east of this divide flows northeast to the North Platte River (HUC 10180002) in the Missouri River Basin. The Continental Divide and the three major drainage basins are depicted in Appendix M: Watershed Basins.

The locations of all USGS surface water gaging stations (both active and discontinued) within and near the ARPA are shown in Appendix M: Surface Waters and Monitoring Stations. Table 3-12 summarizes the available streamflow data from these stations. With the exception of Muddy Creek Station No. 09258980 and North Platte River Station No. 06630000, none of the other nearby gaging stations is currently in use. Data collection has been discontinued for at least the last eight years or was generally short lived or seasonal at the inactive stations. The average flow conditions presented in Table 3-12 therefore do not necessarily represent current flow conditions. As discussed in the climate section, precipitation is highly variable with small and large patterns of drought. However, sufficient data are available to compare flows streams relative to each other.

In 2004, the RFO-BLM sponsored USGS surface water gaging Station No. 09258980, Muddy Creek below Young Draw near Baggs. This station site is located immediately upstream of the discontinued USGS Station No. 09259000, Muddy Creek near Baggs (period of record 1987–1991). The gage was moved in effort to compensate for increased irrigation return flow occurring between the two sites and to reinitiate water quality and quantity monitoring of Muddy Creek. The new surface water monitoring station on Muddy Creek currently records streamflow and conductivity. The streamflow data from these two stations is comparable. Beginning in 2006, the USGS plans to collect water quality samples periodically at Station No. 09258980 in effort to develop a relationship between specific conductance and TDS concentration, and the gage would most likely be maintained throughout the life of the Atlantic Rim project.

Table 3-12. Flow statistics from USGS gaging stations located within and near the ARPA.

Station Name	Station Number	Drainage area (sq. mi.)	Period of Record	Mean Flow[1] (cfs)	Average Annual Runoff (ac-ft/yr)	Median Flow[2] (cfs)	Min. Flow[2] (cfs)	Max. Flow[2] (cfs) Date
Colorado River Basin								
Little Snake River near Dixon	09257000	988	10/1/10 - 9/30/23 10/1/38 - 9/30/71 4/1/72 - 9/30/97[3]	514	372,400	100	0	10,400 5/16/84
Muddy Creek near Baggs	09259000	1,257 (1,187)[4]	10/1/8 - 9/30/91	14.8	10,690	2.8	0.03	632 3/23/88
Muddy Creek below Young Draw near Baggs	09258980	1,150	4/17/04 - present	19.1	13,828	3.7	0.13	236 1/12/05
Savery Creek near Savery	09256000	330	10/1/41 - 9/30/72 3/27/85 - 9/30/92	103	74,390	30	0	2,440 5/4/52
Missouri River Basin								
North Platte River above Seminoe Reservoir, near Sinclair[5]	06630000	4,175 (4,061)[4]	7/1/39 - 9/30/00	1,140	825,800	450	70	14,800 6/11/86
Great Divide Basin								
Separation Creek near Riner	09216527	53	10/1/75 - 9/30/81	1.8	1,300	0	0	76 4/20/80
Separation Creek at upper station near Riner	09216525	42	7/1/75 - 9/30/75	1.3	na	0.8	0.5	21 9/11/75

Source: USGS 2005

[1] Over period of record

[2] Of mean daily values

[3] Daily flow measurements were only made from April through October during this time; not included in calculation of mean or median flow.

[4] Contributing drainage area

[5] Not depicted on Appendix M: Surface Waters and Monitoring Stations.

3.4.2.1 Colorado River Basin

The ARPA is predominantly drained by Muddy Creek, a tributary of the Little Snake River. The Little Snake River flows east to west just south of the project area. The Little Snake River drains the largest basin in the Yampa River Basin (Driver et al. 1984) in northwest Colorado (Appendix M: Watershed Basins). The Yampa River flows southwest to its confluence with the Green River in Colorado. The Green River drains to the Colorado River, which ultimately drains into the Pacific Ocean.

Approximately 75 percent of the ARPA is drained by Muddy Creek. Muddy Creek (HUC 14050004) flows from east to west and then south across the project area to its confluence with the Little Snake River near Baggs. The primary Muddy Creek ephemeral tributaries within the ARPA are include, from upstream to downstream, Cow Creek (and its tributaries Dry Cow Creek and Deep Gulch), Wild Cow Creek, Cherokee Creek, and Deep Creek (Appendix M: HUC Boundaries). These four tributaries experience intermittent streamflow in portions due to the presence of springs, seeps, and flowing wells in their headwater areas, similar to Muddy Creek, but are predominantly ephemeral and flow only in response to snowmelt and rainfall. There are also numerous unnamed, ephemeral tributaries of Muddy Creek within the project area.

The extreme southeast margin of the ARPA drains to the Little Snake River via Savery Creek. The main channel of Savery Creek flows north to south immediately east of the ARPA. The headwaters of two named ephemeral tributaries of Savery Creek, Negro Creek and Loco Creek, originate in the ARPA.

Muddy Creek is described as a high-elevation, cold-desert stream. Muddy Creek originates in the Sierra Madre Range, which is located immediately east of the ARPA, and extends to the Red Desert, immediately west of the ARPA. The watershed encompasses approximately 182 square miles, ranges in elevation from about 6,300 feet to about 8,200 feet, and extends from the Sierra Madre Range (to the east of the ARPA) to the Red Desert (to the west of the ARPA). The upland watershed is dominated by sagebrush and riparian vegetation within the valley is primarily willow and greasewood in addition to sedges and rushes (Beatty 2005).

Beatty (2005) divided Muddy Creek into two major segments, upper Muddy Creek and lower Muddy Creek. The upper segment is identified as that portion of the watershed upstream of a large headcut stabilization structure that is located in T.17N., R.92W., located just downstream of where Muddy Creek crosses the ARPA boundary and just upstream of where Muddy Creek crosses Highway 789. The four primary tributaries mentioned above are within the lower segment, which extends from the large headcut stabilization structure to the Little Snake River confluence. Lower Muddy Creek is highly erosional and has abundant channel incision (Beatty 2005). Channel substates consist predominantly of very fine-grained sediments (sands, silts and clays) in the lower segment, while most of the rock substrates (gravels and cobbles) occur in the upper segment. In addition, a large wetland complex occurs on the reach of Muddy Creek that lies west of Highway 789, in T.16N., R.92W. This wetland area (George Dew Irrigated Meadows) consists of impoundments, man-made channels, vertical drop structures, headgate structures for water diversion, overflow spillways, and a braided stream channel network (Beatty 2005).

Streamflow in Muddy Creek and its tributaries varies with location along the drainage. An appreciable amount of snow accumulates at the higher elevations of the watershed, particularly in the more protected areas having pronounced gullies and canyons; therefore, the snowmelt during the spring months accounts for a significant runoff event from tributaries draining these

headwaters areas. Spring snowmelt runoff generally occurs from March through mid-June. Additional high flow events can occur in response to precipitation events occurring during the summer and fall months. Numerous springs occur within the ARPA and they contribute perennial low flows to the headwater tributaries; however, losses to seepage and evapotranspiration deplete these flows so the downstream reach of Muddy Creek generally has intermittent flows.

Wetland habitat has been created around a number of flowing wells within the ARPA, but like springs, their contribution to streamflow is relatively insignificant due to seepage and evapotranspiration losses. A discussion on springs and flowing wells in the ARPA is included in the groundwater section. The relative yield from rainstorms becomes more significant in the lower elevations of the drainage basin. Base flow and intermittency commonly occurs from July through September, but can occur as early as April (Goertler 1992). Particularly within the lower segment of the Muddy Creek basin, tributary channels are generally dry and prone to flashy, periodic flood events from isolated thunderstorm systems from May to October.

Of the four nearby Colorado River Basin gaging stations (Table 3-12); the Muddy Creek stations measure runoff from the largest drainage area. However, the average flow in Muddy Creek near Baggs, which is at its mouth, is much less than that measured at the Little Snake River or Savery Creek gaging stations. This is because the headwaters of the Little Snake and portions of Savery Creek are in the Sierra Madre range. The Average (mean) Muddy Creek flow during the period of record at the discontinued site was 14.8 cubic feet per second (cfs) and 19.1 cfs at the active site, as compared to 514 cfs in the upper Little Snake River and 103 cfs in Savery Creek. In general, Muddy Creek experiences higher individual events and lower annual water yield due to climate conditions discussed previously.

Unit runoff, calculated by dividing the average annual runoff into the effective drainage area, is much lower in Muddy Creek. Unit runoff in the Muddy Creek drainage basin was about 0.2 inches per year, as compared to 7.1 inches per year in the upper Little Snake River drainage basin and 4.2 inches per year in the Savery Creek basin. The calculated median flows, which discount the effect of short-duration, high-volume flood events, are 2.8 cfs and 3.7 cfs at the two Muddy Creek stations, and 100 cfs and 30 cfs at the Little Snake River and Savery Creek stations, respectively. Excluding the active Muddy Creek gaging station, the median flow rates of the three Colorado River Basin stations were calculated only during the time period in which all three stations were active: October 1, 1987 through September 30, 1991, excluding the months of November through March. During this time period, the median flows in Muddy Creek, Little Snake River, and Savery Creek were 6.9 cfs, 13.5 cfs, and 25 cfs, respectively. These calculations demonstrate that some of the differences between the average flow and median calculations presented in Table 3-12 may be caused by climactic differences between the differing periods of record. Because precipitation varies significantly from year to year, runoff varies significantly as well.

Much of the Muddy Creek watershed is managed by the BLM (Section 3.6) and the land has historically been managed primarily for its range resources (agricultural uses, primarily grazing), as well as wildlife habitat, energy exploration, development, and transportation, and recreational uses. Given these land uses and the area's unique geographic location and climatic characteristics, the Muddy Creek watershed has been extensively studied from water availability, water quality, and aquatic biology viewpoints.

A partial list of citations for this research in Muddy Creek follows:

Three native warm water fish species listed as BLM sensitive species and co-exist in portions of both upper and lower Muddy Creek within the ARPA. These species have been extensively studied to determine habitat associations, life history and interactions with non-native fish species (Quist et al., in press; Bower 2005). The lower portions of Muddy Creek have been studied to determine the role of anthropogenic disturbances as well as the distribution and life history of native fishes (Beatty 2005).

Extensive cooperative management projects have been undertaken to improve watershed conditions and the RFO-BLM has been a strong participant in many of these efforts in conjunction with water conservation districts, local government and land owners (Thompson, 2001; NARCS, 2000; Hicks and Warren, 1992 and1997; BLM, 1987; Hicks et al. 1996; and Fanning, 1986).

There has also been extensive research into surface–groundwater interactions, riparian system function, geomorphology, sediment dynamics and other basic research (Peterson, 1993; Goetler, 1992; Middleton, 1992; Skinner et al., 1989 and 1991, and Dolan and Wesche, 1987).

3.4.2.2 Great Divide Basin

The northwest portion of the ARPA (roughly 20 percent) drains into the Great Divide Basin via Separation Creek, including its tributary, Fillmore Creek. Separation Creek flows north to Separation Lake, which is a depression having no outlet and is located about 15 miles north of Rawlins. The Great Divide Basin is a closed basin – bounded by the Continental Divide on all sides and has no hydrologic outlet (USGS 1976; Seaber et al. 1987). The Great Divide Basin is a relatively shallow depression with isolated buttes, pan-like depressions, and sparse vegetation. Numerous ephemeral streams flow somewhat toward the center of the Great Divide Basin before disappearing in the soil or ending in natural or man-made impoundments. There are some spring-fed systems like Battle Springs Flat and unique alkaline wetland systems around Chain Lakes. In general Streams within the Great Divide Basin are ephemeral but can be intermittent in sections. These systems flow mainly in response to direct runoff from rainstorms and snowmelt (Lowham et al. 1976).

Springs provide some flow in the upstream reaches of the Separation Creek; however, groundwater inflow is not sufficient to maintain flow without snowmelt and rainfall. Some peak flows estimated for the creek in the downstream reaches are 39 cfs for a 2-year flood and 420 cfs for a 50-year flood. Estimated annual discharge for downstream reaches of Separation Creek is 2,500 acre-feet (Larson and Zimmerman 1981).

Separation Creek is classified by the WDEQ as a Class 4C stream (WDEQ 2005), defined as those waters that do not support fisheries or other aquatic life uses and it is not protected for those uses. It is however protected for agricultural, wildlife watering, and recreational uses. Beaver have greatly affected the streamflow, water quality, and aquatic habitat within the upper-most reaches of Separation Creek within Jep Canyon. The springs and seeps in Jep Canyon are not able to sustain streamflow throughout the year; however, they do sustain many of the beaver ponds in the headwater areas (Larson and Zimmerman 1981).

Groundwater is the most reliable source of water in Upper Separation Creek Basin. Springs and windmills presently supply water to wildlife and livestock (Larson and Zimmerman 1981).

3.4.2.3 Missouri River Basin

The northeast portion (roughly five percent) of the ARPA drains into the North Platte River via Sugar Creek. Although the USGS does not maintain a gaging station on Sugar Creek, limited instantaneous flow data are available from USEPA and Wyoming Department of Environmental Quality (WDEQ) monitoring stations near Rawlins (WRDS 2004). According to 14 instantaneous flow measurements collected at two stations during 1973, 1975, and 1976, Sugar Creek was flowing between 1 and 3 cfs, with a mean flow of 2.1 cfs. Sugar Creek drains the northwestern slope of the Atlantic Rim.

The headwaters of Little Sage Creek, a tributary to Sage Creek, begin at the eastern edge of the ARPA; an extremely small portion of the ARPA. The mainstem of Sage Creek begins east of the ARPA and flows northeast to its confluence with the North Platte River between Saratoga and Rawlins, Wyoming. Limited flow data are available from two BLM gaging stations on Little Sage Creek (WRDS 2004). Based on 36 instantaneous flow measurements recorded during May through November, 1978, and May through September, 1979, the average Little Sage Creek flow during these months was 1.8 cfs, and the median flow was 0.8 cfs.

3.4.3 Surface Water Rights

Based on a review of Wyoming State Engineer's Office (SEO) surface water rights, there are 195 permitted surface water rights within the originally scoped portion of the ARPA. Table 3-13 summarizes the rights according to designated uses. A second surface water rights search was performed for each of the major drainage basins intersecting the scoped ARPA. Table 3-14 summarizes the rights within each basin.

The Wyoming Game and Fish Department (WGFD) maintains a database of lakes, reservoirs, and ponds in the state (WGFD 2004a). A search of the most recent WGFD database revealed the presence of 14 reservoirs and ponds in the scoped ARPA. The waterbodies varied from 0.5 acres to 20 acres. Seven were owned or controlled by the USDI-BLM, six by private individuals, and one by the state of Wyoming. Table 3-15 lists the reservoirs and ponds catalogued by the WGFD.

Table 3-13 Surface water rights within the ARPA.

SEO Use Designation	Surface Water Rights
Stock	161
Irrigation	12
Stock and irrigation	4
Domestic supply (in addition to stock and/or irrigation use)	10
Industrial	1
Reservoir supply	3
Wildlife and fish propagation	4
Total surface water rights within the ARPA	**195**

Table 3-14. Surface water rights within major drainage areas.

SEO Use Designation	Muddy Creek	Savery Creek	Separation Creek[1]	Sage Creek	Sugar Creek
Stock	272	145	43	51	22
Irrigation	26	60	7	36	13
Stock and irrigation	9	7	6	1	6
Domestic supply (in addition to stock and/or irrigation use)	12	18	3	16	15
Industrial - pollution control and flood control	13	9		1	6
Municipal				14	31
Reservoir supply	2	1		3	1
Railroad and steam supply				13	2
Wetland, wildlife, and fish propagation	9	9		1	
Mining		9			
Power development		2		1	2
Recreation		2	1	1	
(none listed)	2	1		1	
Totals by Drainage Area	344	257	60	142	98

[1] to confluence with Fillmore Creek

3.4.4 Waters of the United States

The surface water features in the ARPA, except those within the internally drained Great Divide Basin, qualify as Waters of the U.S. Waters of the U.S. include the territorial seas; interstate waters; navigable waterways (such as lakes, rivers, and streams), special aquatic sites, and wetlands that are, have been, or could be used for travel, commerce, or industrial purposes; tributaries; and impoundments of such waters. All channels that carry surface flows and that show signs of active water movement are Waters of the U.S. Similarly, all open bodies of water (except ponds and lakes created on upland sites and used exclusively for agricultural and industrial activities or aesthetic amenities) are Waters of the U.S. (USEPA 33 CFR § 328.3(a)). Such areas are regulated by the USEPA and the U.S. Army Corps of Engineers (ACOE). Many of the drainage channels identified on the USGS topographic maps are vegetated swales, which are not considered to be Waters of the U.S. by the ACOE. Any activity that involves discharge of dredge or fill material into or excavation of such areas is subject to regulation by the ACOE pursuant to Section 404 of the CWA. Activities that modify the morphology of stream channels are also subject to regulation by the Wyoming SEO. Special aquatic sites and wetlands are discussed in greater detail in the Vegetation Section (Section 3.5).

Table 3-15. Reservoirs, lakes, and ponds in the ARPA.

Water Body	Source Water	Acres	Ownership
Brazel Reservoir	Dry Cow Creek	1	USDI-BLM
Doty Mountain Reservoir	Dry Cow Creek	20	USDI-BLM
Dry Cow Reservoir	Dry Cow Creek	2	USDI-BLM
Horse Gulch Reservoir	Muddy Creek	3	Private
J-O Reservoir	Cow Creek	2	State
J-O Reservoir #1	Dry Cow Creek	1.5	Private
J-O Reservoir #2	Dry Cow Creek	2	Private
J-O Reservoir #3	Dry Cow Creek	3	Private
J-O Reservoir #4	Dry Cow Creek	1	Private
Lower Deep Gulch Pond	Cow Creek	3	USDI-BLM
Retention Reservoir	Deep Creek	5	USDI-BLM
Smiley Draw Reservoir	Cherokee Creek	6	USDI-BLM
Willie Reservoir	Loco Creek	2.5	Private
Willow Road Pond	Dry Cow Creek	0.5	USDI-BLM

Source: WGFD (2000)

3.4.5 Surface Water Quality

Various federal and state agencies, including the USGS, USDI-BLM, USEPA, and WDEQ have measured the surface water quality in and around the ARPA. Surface water samples have been analyzed for physical and chemical properties, salinity, major ions, metals, radionuclides, and/or specific toxins. The locations of these agencies' surface water quality sampling sites in and around the ARPA are depicted in Appendix M: Surface Waters and Monitoring Stations. The chemical analyses of most surface water samples that have been collected within the ARPA can be accessed through the State of Wyoming's Water Resources Data System (at web site http://www.wrds.uwyo.edu/) and the USGS's database (at web site http://waterdata.usgs.gov/usa/nwis/).

In the arid, high plains of southwestern Wyoming, surface water quality, like streamflow, is variable both spatially and temporally. Perennial stream water quality is generally of better quality than that of the ephemeral and intermittent streams. The quality of runoff is largely dependent upon the rates of salts, sediments, and organic materials that accumulate in the dry stream channels between periods of runoff. Factors that can govern the rate of buildup of these materials are the basin's physical characteristics, land uses, and season of the year. Periodic flushing of accumulated salts and sediments from the ephemeral and intermittent streams occurs during flow events, which is the only time that water quality samples can be collected, accounting for greater concentrations of dissolved and suspended solids recorded in the analyses. In general, when quantity of runoff decreases, the quality decreases. In less arid

areas having more flushing and less evaporation, coupled with more baseflow, the action of flushing and sharp fluctuations of water quality would be less significant (Larson and Zimmerman 1981, Lowham et al. 1982).

Water quality is classified by the State of Wyoming based on beneficial uses. Table 3-16 and 3-17 show the classifications of Wyoming surface waters located in or near the ARPA.

Table 3-16. Classification of Wyoming surface waters.

	Drinking Water	Game Fish	Non-Game Fish	Fish Consumption	Other Aquatic Life	Recreation	Wildlife	Agriculture	Industry	Scenic Value
1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2A	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3A	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3C	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4A	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4B	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4C	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

3.4.5.1 Baseline Water Quality Data

A summary of the water quality data from each of seven USGS surface water sampling stations located in the Little Snake River watershed within the scoped ARPA (two on Little Snake River, three on Muddy Creek, and one each on Cow Creek and Dry Cow Creek) for the respective periods of record are shown on Table 3-18. The two Little Snake River stations represent perennial stream surface water quality in the area, the three Muddy Creek stations represent intermittent stream surface water quality in the ARPA, while the water quality in ephemeral streams is represented by the Cow and Dry Cow Creek monitoring stations.

Table 3-17. Classification of streams in the ARPA.

Surface Water	Classification
Colorado River Basin	
Little Snake River	2AB
Muddy Creek (mouth to Sec. 29, T.17N., R.89W.)	2C
Muddy Creek (remainder)	2AB
McKinney Creek	2AB
Cow Creek	2C
Dry Cow Creek	3B
Wild Cow Creek	2C
Cherokee Creek	2C
Deep Creek	3B
Savery Creek	2AB
Loco Creek	2C
Negro Creek	3B
Missouri River Basin	
Separation Creek	4C
North Platte River Basin	
North Platte River (Sage Creek to Colorado state line)	1
North Platte River (Kortes Dam to Sage Creek)	2AB
Sage Creek	2AB
Little Sage Creek	2C
Sugar Creek	3B

Source: WDEQ (2005a)

Table 3-18. Surface water quality in the ARPA.

	USGS Surface Water Quality Station						
	Little Snake River	Little Snake River	Muddy Creek	Muddy Creek	Muddy Creek	Cow Creek	Dry Cow Creek
Station Number	**09257000**	**09259050**	**09258900**	**09259000**	**09258980**	**09115080**	**09258200**
Sample period	1957-1988	1980-1997	1976-1978	1957-1991	May 2005-present[1]	1978-1979	1975-1980
Number of samples[2]	107	100	3	41	nm	20	9
pH	8.1	8.1	8.6	8.2	nm	9.2	8.6
Conductance, µmhos/cm (mean)	$259_{(34)}$	$366_{(90)}$	$1,350_{(2)}$	$966_{(35)}$	$1,300_{(111)}$	$2,925_{(18)}$	$2,162_{(5)}$
Conductance, µmhos/cm (min.)	82	87	600	529	598	700	460
Conductance, µmhos/cm (max.)	460	855	2,100	1,790	3,550	7,500	3,800
TDS (mean)	$158_{(9)}$	$243_{(17)}$	$913_{(2)}$	$346_{(1)}$	nm	$1,801_{(6)}$	$292_{(1)}$
TDS (min.)	46	87	396	346	nm	561	292
TDS (max.)	260	540	1,430	346	nm	3,013	292
Suspended solids[3] (mean)	$154_{(101)}$	$228_{(25)}$	$6,198_{(2)}$	$3,191_{(41)}$	nm	$133_{(6)}$	$1111_{(9)}$
Suspended solids[3] (min.)	4	6	195	7	nm	30	8
Suspended solids[3] (max.)	1,180	852	12,200	22,500	nm	315	6,180
Turbidity, JTU	13	167	1,260	nm	nm	284	1,013
Calcium	30	34	54	42	nm	19	9
Magnesium	8	12	44	40	nm	31	4
Potassium	2	2	7	9	nm	11	4
Sodium	11	26	200	286	nm	560	98
Bicarbonate	159	190	373	308	nm	870	170
Sulfate	25	54	380	320	nm	181	65
Chloride	3	2	65	32	nm	132	21
Iron, µg/L	74	164	105	nm	nm	2,903	200
Hardness ($CaCO_3$)	111	151	315	270	nm	174	37
Dissolved Oxygen	9	10	11	10	nm	9	11

[1] Daily mean values analyzed: May 27, 2005 to September 14, 2005.
[2] Total number of grab samples analyzed; not every parameter was analyzed in every sample.
[3] Total concentration; except as noted here, all reported values represent dissolved concentrations.
All units are mg/L except as noted.
nm = not measured
$_{(34)}$ = Number of samples analyzed for that parameter.

As Table 3-18 indicates, considerably more measurements of specific conductance have been recorded than total dissolved solids (TDS) concentrations at these seven surface water sampling stations. For individual streams, a good relationship can commonly be established between specific conductance and total dissolved solids concentration. In general, as ionic

concentrations increase, conductance increases (Hem 1970). Therefore, specific conductance measurements of streams in the project area are related to the dissolved solids concentrations. The USGS intends to collect periodic TDS concentration samples at Muddy Creek Station No. 09258980 beginning in 2006 so that a relationship between conductivity, which is presently monitored hourly on a real-time basis continuously, and TDS concentration can be determined.

Surface water quality within the Muddy Creek drainage basin, like streamflow, is variable both spatially and temporally. The ephemeral stream water quality, represented by the two Muddy Creek tributaries, is characterized by high and widely variable conductance and TDS concentrations (ranging from about 560 mg/L to over 3,000 mg/L), and the predominant ions are sodium and bicarbonate. The intermittent stream water quality, represented by Muddy Creek, is characterized by moderate conductance and TDS concentrations (ranging from around 350 mg/L to 1,400 mg/L), and the predominant ions are sodium, sulfate, and bicarbonate. The perennial stream water quality, represented by Little Snake River, is characterized by significantly reduced conductance and TDS concentrations (ranging from around 50 mg/L to 550 mg/L), and the water type is calcium bicarbonate. Note that limited samples were available from the ephemeral tributaries, and the samples that were available tended not to always coincide with the infrequent flood events. Short-duration flood events in response to precipitation or snow melt typically cause an abrupt, temporary increase in the concentration of dissolved constituents followed by a decrease due to the flushing of the channels and basin surface and a dilution effect. The larger variation and relatively higher conductance values measured in the ephemeral streams, where baseflow is responsible for a small part of the overall streamflow, illustrates the how the quality of runoff from those stream reaches is influenced by the flushing of salts by flood events.

Based upon the historical USGS surface water quality analyses (Table 3-18), the average TDS concentration in the perennial Little Snake River below Baggs was about 250 mg/L, compared to roughly 900 mg/L in the intermittent Muddy Creek just upstream of its confluence with the Little Snake River, and almost 2,000 mg/L in the ephemeral Cow Creek near its mouth. Though a limited number of TDS analyses are available from Muddy Creek at Station No. 09259000, the average TDS concentration at this location was estimated using a regression analysis of conductance values recorded at that station and at Station No. 09258980.

As indicated in Table 3-18, surface waters in the ARPA are of moderately basic (or high) pH (8.1 to 9.2) and have a moderate concentration of dissolved oxygen (9 to 11 mg/L). WDEQ/WQD (2005) defines 9.0 as the upper pH limit for full aquatic life support. Hardness varied between soft (37 mg/l $CaCO_3$) in Cow Creek to hard (315 mg/l $CaCO_3$) in Muddy Creek.

As the name Muddy Creek implies, the suspended solids concentration is typically high. Suspended sediment concentrations, like total dissolved solids concentrations, are greater in the ephemeral and intermittent streams than the perennial Little Snake River. This, in part, is apparently the result of a flushing action similar to the flushing of salts. The ephemeral and intermittent channels, as well as the basin's surface, that have periods of no flow accumulate loose material due to weathering, bank caving, livestock and wildlife movement, and wind deposits. This loose material is then readily picked up by the turbulent first flows of a flood event. Once the channels and basin surface have been flushed, then the suspended sediment concentration is dependent upon the magnitude of the runoff event and the erodability of the land surface and stream channel. As stated in the Reclamation Potential discussion in Section 3.3, poor to fair topsoils occupy approximately 81.5 percent of the total land surface of the ARPA; therefore, reclamation potential is fair to poor. This is due to factors including steep slopes and high clay and silt content soils that can cause moderate to severe water and wind

erosion and have moderate to high runoff potential. The relatively high total suspended solids (TSS) concentrations recorded in Muddy Creek flows (concentrations averaging about 6,200 mg/L and a high value of 12,200 mg/L) are indicative of the relatively high percentage of the land surface in the basin that has high (40 percent in the ARPA) or moderate to high (about 35 percent in the ARPA) runoff potential (Section 3.3).

Turbidity varied from 13 Jackson turbidity units (JTU) in Little Snake River to 1,260 JTU in Muddy Creek. The moderate to high turbidity measurements were likely caused by the moderate to high measurements of suspended sediment (predominantly clay particles and organics).

Table 3-19 presents a summary of all Muddy Creek water quality samples that were available from the State of Wyoming's WRDS database prior to installation of the new USGS Station No. 09258980 in 2004. Constituent concentrations on Table 3-19 represent the geometric mean of all the respective water quality constituents over the period of record (being 1933, 1976, 1978, 1979, and 1986 through 1993) at 16 separate water quality sampling stations throughout the Muddy Creek drainage basin (Appendix M: Surface Waters and Monitoring Stations). The average specific conductance is moderate at 599 micromhos per centimeter (µmhos/cm), pH is slightly basic at 8.2, the TDS concentration is 442 mg/L, and the water is a calcium-bicarbonate type. High TSS (maximum concentration of 22,500 mg/L), coupled with high fecal coliform bacteria concentrations indicate that Muddy Creek would likely require disinfection and filtration if it were to be used as a potable supply. Naturally occurring radionuclides may also restrict the use of Muddy Creek as a drinking water supply. Mean uranium, gross alpha, and gross beta concentrations were 11 micrograms per liter (µg/L), 22 picocuries per liter (pCi/L), and 4.6 pCi/L, respectively. It is important to emphasize that the values in Table 3-19 do not necessarily represent the surface water quality at any particular location within the Muddy Creek drainage basin during any particular season of the year, but rather, are the composite representation of Muddy Creek water quality.

Figure 3-2 compares the major ion characterization of each surface waterway. The major ion concentrations from Table 3-19 are plotted on Figure 3-2 for Muddy Creek, as were the geometric means of the major ions determined from all water samples that have been collected from the other streams depicted. Ephemeral Dry Cow Creek, Cow Creek, Wild Cow Creek, and Little Sage Creek exhibited sodium dominance, while the intermittent Muddy Creek and the perennial Little Snake River and North Platte River exhibited calcium dominance. With the exception of Separation Creek, which is sulfate dominant, all surface waterways exhibited bicarbonate anion dominance.

Table 3-19. Muddy Creek water quality.

Parameter	Unit	Mean[1]	Count	Max	Min
Specific conductance	µmhos/cm	599	128	2,450	324
Total dissolved solids	mg/L	442	31	1,430	227
Total suspended solids	mg/L	144	56	22,500	0.2
Turbidity	NTU	23	56	2,500	1.1
pH	standard units	[illegible].2	137	8.7	[illegible].2
Dissolved oxygen	mg/L	9.0	71	17.6	4.0
Hardness as $CaCO_3$	mg/L	258	134	555	100
Alkalinity as $CaCO_3$	mg/L	182	113	992	83
Calcium	mg/L	76	136	171	22
Magnesium	mg/L	12	136	84	3.9
Sodium	mg/L	15	135	300	3.9
Potassium	mg/L	4.3	135	51	1.6
Sodium adsorption ratio	none	0.43	135	10	0.01
Sulfate	mg/L	116	135	668	1.1
Chloride	mg/L	12	135	359	0.7
Bicarbonate	mg/L	214	135	2729	109
Carbonate	mg/L	1.2	115	47	< 1
Fluoride	mg/L	0.3	134	2.8	< 0.1
Silica	mg/L	15	[illegible]	90	5.6
Coliforms, fecal	count/100 mL	78	71	1,650	3
Aluminum, dissolved	µg/L	50[2]	1	< 100	< 100
Arsenic, dissolved	µg/L	2.0	1	2	2
Barium, dissolved	µg/L	50	1	< 100	< 100
Beryllim, dissolved	µg/L	nm[3]	nm	nm	nm
Boron, dissolved	µg/L	64	1	360	10
Cadmium, dissolved	µg/L	9.0	1	< 1	< 1
Chromium, dissolved	µg/L	0.5	1	< 1	< 1
Cobalt, dissolved	µg/L	nm	nm	nm	nm
Copper, dissolved	µg/L	1.0	1	< 2	< 2
Iron, dissolved	µg/L	51	9	200	< 30
Lead, dissolved	µg/L	0.5	1	< 1	< 1
Mangansese, dissolved	µg/L	21	1	90	< 10
Mercury, dissolved	µg/L	0.25	1	< 0.5	< 0.5
Molybdenum, dissolved	µg/L	3	1	[illegible]	3
Selenium, dissolved	µg/L	3	1	3	3
Silver, dissolved	µg/L	0.5	1	< 1	< 1
Uranium, dissolved	µg/L	11	2	16	6.9
Zinc, dissolved	µg/L	10	1	< 20	< 20
Radium 226	pCi/L	0.5	2	1.2	0.17
Gross alpha	pCi/L	22	2	23	22
Gross beta	pCi/L	4.6	2	6.5	3.3

Source: WRDS (2002)

[1] geometric mean

[2] assumed half of detection limits for samples reporting "no detect"

[3] nm = not measured

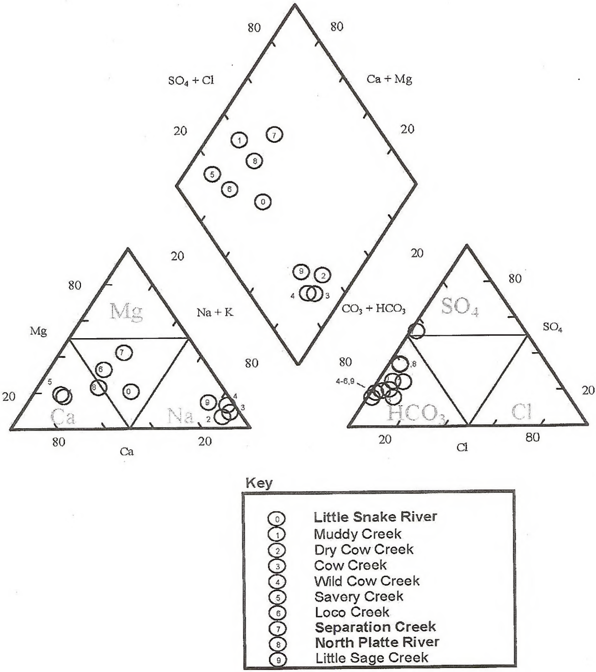
Figure 3-3 compares the irrigation suitability of the streams in and around the ARPA. Again, geometric means of the specific conductance and sodium adsorption ratio (SAR) values were determined from all water quality samples available from the State of Wyoming's WRDS database for these streams (WRDS 2002). The figure combines USDA (1954) and Ayers and Wescott (1985) information on classifying irrigation waters. The irrigation suitability is a function of SAR and salinity as measured by specific conductance. The perennial and intermittent streams are all in the C1-S2 category. The low salinity (C1) classification indicates that the water can be used for all crops and soils where salt toxicity is concerned. The moderate sodium (S2) classification indicates that the water may cause clay particles in irrigated soils to swell and disperse, and thereby reduce soil infiltration rate. The ephemeral streams in the ARPA are generally in the C2-S2 category, indicating that the yield of salt-sensitive crops may be reduced.

When flows are available and based on average values, Muddy Creek is moderately suitable as an irrigation water supply. As shown on Figure 3-3, Muddy Creek does not pose a salinity hazard to irrigated crops. However, due to the flashy flows and limited data it would be difficult to be very confident about this determination. Muddy Creek in general is a good supply of water for livestock and wildlife when it flows, and would be suitable for crops such as native hay.

Numerous miscellaneous surface water quality samples were obtained from various locations within the upper Separation Creek watershed, both within and outside of the ARPA, as part of the Separation Creek study by Larson and Zimmerman (1981). Snowmelt is the principal source of streamflow. Specific conductance measured at USGS Station No. 09216527 (Appendix M: Surface Waters and Monitoring Stations) ranged from 200 to 2,000 μmhos/cm (or a TDS concentration of about 1,400 mg/L). Surface water in Separation Creek tends to be slightly to highly alkaline, having and average pH of 8.0. Total phosphorous concentration averaged 0.16 mg/L, which is slightly above the EPA criterion for stream protection (0.1 mg/L). Separation Creek carries and deposits sediments to the center of the Great Divide Basin. Suspended sediments are predominantly comprised of clay and silt. Separation Creek has an average suspended sediment concentration of 506 mg/L. The chemical quality of upper Separation Creek streamflow was found by Larson and Zimmerman (1981) to be suitable for its present uses, which are livestock watering and irrigation of native hay.

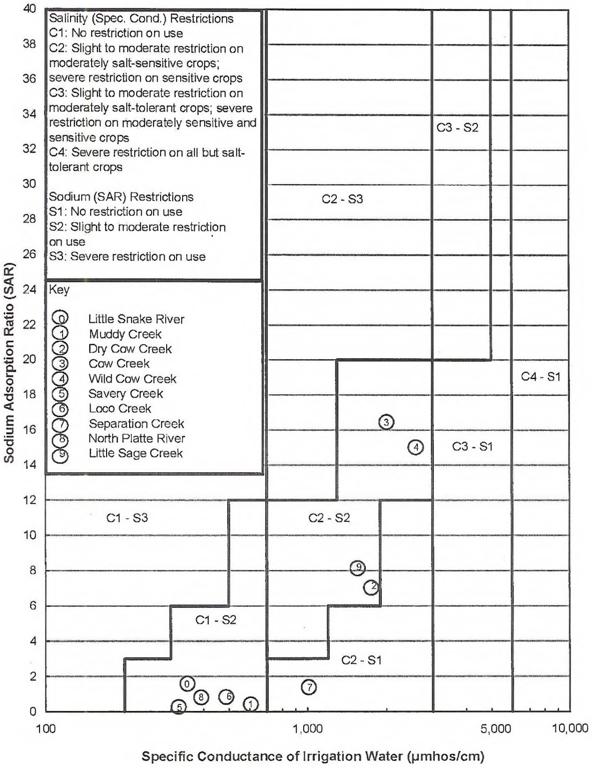
3.4.5.2 Waterbodies with Impairments or Threats

Various streams in the ARPA are identified in WDEQ's 2004 Wyoming 305(b) Water Quality Assessment Report to the USEPA (WDEQ 2004b) as having water quality impairments or threats. Table 3-20 summarizes the streams and potential problem parameters as listed on Wyoming's 303(d) list of waterbodies with water quality threats. Threatened or impaired stream segments in and around the ARPA are depicted in Appendix M. Impaired or threatened streams in the Little Snake River watershed (HUC 1405003 and 1405004) include portions of Muddy Creek, McKinney Creek, West Fork Loco Creek, Savery Creek, Haggarty Creek, and West Fork Battle Creek. According to the 2004 305(b) report, unstable stream channels and loss of riparian functions threaten aquatic life uses in Muddy Creek and McKinney Creek.



Data source: WRDS (2002)

Figure 3-2. Major ion composition of streams in and around the ARPA.



Note: Figure modified from USDA Agriculture Handbook 60 (1954) to include Hanson et al. (1999) classification lines

Figure 3-3. Irrigation suitability of streams in and around the ARPA.

The Little Snake River Conservation District (LSRCD) has been addressing these problems with the cooperation of the USDI-BLM, landowners, grazing permittees, WGFD, and other stakeholders since 1992. Several 319 watershed improvement projects have been implemented, including developing upland water supplies, developing wetlands, re-establishing flood plains, cross fencing, and managing grazing and vegetation. Additional watershed improvement projects have been coordinated by WGFD. These projects resulted in improvements to stream stability, aquatic habitat and riparian areas. As a result, Muddy Creek and Littlefield Creek above their confluence, and McKinney Creek above Eagle Creek are now meeting their aquatic life uses. Because of the improved water quality, Colorado River cutthroat trout have been re-introduced into their former habitat in Littlefield Creek (USDI-BLM 2004a).

Water development projects have been implemented on the reach of Muddy Creek lying west of Highway 789 to address physical degradation of the stream channel, which threatens its aquatic life use support. This reach of Muddy Creek is also on Table C of the 303(d) list. Implementation measures include wetland development, re-establishment of the floodplain and irrigation water management. Results of this project show an improving trend in riparian condition and bank stability above Red Wash, according to the LSRCD.

However, habitat degradation has been identified by the BLM and LSRCD as a serious water quality concern on Muddy Creek, from Red Wash downstream to the Little Snake River. The habitat degradation is likely caused by season long riparian grazing, exacerbated by accelerated erosion associated with oil and gas activities. Several grazing management BMPs are being implemented in much of this lower watershed, including changes in length, timing and duration of grazing and cross fencing (USDI-BLM 2004a).

The upper portions of Muddy Creek and McKinney Creek to the confluence of Eagle Creek have been listed as having threats based on habitat degradation for non-game fish, coldwater fish and aquatic life. Changes in upland runoff, hydrology and/or increased sedimentation could reduce habitat for non-game fish, coldwater fish and aquatic life. Habitat for these species includes pools and riffles. With increased sediment loads riffles can become silted in and pools can fill, degrading the habitat. Changes in upland runoff conditions can increase peak flow conditions and may reduce base flows critical for maintaining late season pool habitats. Current road densities in these areas are less than 2 mi/sqmi, and accounts for a small amount of sediment delivery. Changes in grazing practices have generally improved vegetation conditions and improved rainfall/runoff conditions.

In Savery Creek and West Fork Loco Creek, physical degradation of the stream channels is threatening full aquatic life use support. The LSRCD is currently implementing a 319 watershed improvement project to address the threats. Portions of Haggarty Creek and West Fork Battle Creek, both east of the ARPA, are included on the 2004 303(d) list of impaired streams due to high copper, silver, and cadmium concentrations. The sources of the metals have been identified as natural and the Ferris-Haggarty Mine, which is located near the headwaters of Haggarty Creek.

Table 3-20. 2004 303(d) Waterbodies with Impairments or Threats.

Surface Water	Impairments or Threats	Location	Impairments/ Threats	Use Impaired/ Threatened	Date	Priority
Little Snake River Basin (HUC 14050003 and HUC 14050004)						
Muddy Creek	Threats	West of State Hwy 789	Habitat degradation; salinity	Non-game fishery; aquatic life	1996	Low
Muddy Creek	Threats	Above Alamosa Gulch to Littlefield Creek	Habitat degradation	Cold water fishery; aquatic life	1996	Low
McKinney Creek	Threats	Above Muddy Creek to Eagle Creek	Habitat degradation	Cold water fishery; aquatic life	1996	Low
Savery Creek	Threats	Below Little Sandstone Creek to Little Snake R.	Habitat degradation	Cold water fishery; aquatic life	1998	Low
Loco Creek West Fork	Threats	All of West Fork watershed above Loco Creek	Habitat degradation; nutrients; temperature	Cold water fishery; aquatic life	1996	Low
Haggarty Creek	Impairments	From Ferris-Haggarty Mine to W. Fk. Battle Ck.	Copper, silver, and cadmium	Cold water fishery; aquatic life	1996	Low
West Fork Battle Creek	Impairments	From Battle Creek to Haggarty Creek	Copper	Cold water fishery; aquatic life	2000	Low
Missouri River Basin (HUC 10180002)						
Sage Creek	Threats	From confluence with North Platte River to State Hwy 71	Habitat degradation	Cold water fishery; aquatic life	1996	Low

Source: WDEQ (2005)

In the Upper North Platte River basin (HUC 10180002), the only stream currently listed as impaired or threatened is Sage Creek. According to the 2004 305(b) report, this creek has naturally high sediment load due to the erosive soils and arid climate in the watershed. A 319 watershed project was instated in 1997 by the Saratoga-Encampment-Rawlins Conservation District (SERCD) in cooperation with the USDI-BLM, NRCS, WGFD, and landowners. The project has resulted in reduced sediment loading through a combination of short duration grazing, riparian and drifts fencing, upland water development, improved road management, grade control structures, and vegetation filtering.

WDEQ classifies Wyoming surface water resources according to quality and degree of protection. Table 3-16 summarizes the classification system based on acceptable uses. Table 3-17 lists the DEQ classification of surface waters in the ARPA. The Little Snake River, Savery Creek, Sage Creek, and the North Platte River have been included with streams in the ARPA for comparison purposes.

3.4.5.3 Salinity Issues in the Colorado River Basin

The majority of the ARPA is located in the Colorado River Basin and, as such, point source discharge permits are subject to provisions of the Colorado River Basin Salinity Control Forum. As one of the seven member states of the forum, Wyoming reviews point and nonpoint sources of salinity in the Wyoming portion of the Colorado River Basin through a watershed protection program administered by the WDEQ/WQD (CRBSCF 1999).

In a study of mechanisms affecting salt pickup and transport in surface runoff, and possible means of reducing salinity in runoff from rangelands in the upper Colorado River Basin, Bentley and others (1978) determined that properly implemented control measures may be able to reduce erosion and salinity (Lowham et al. 1982).

3.4.5.4 Current POD Conditions

During the month of April 2005 a monitoring project was undertaken to evaluate the nine PODs approved during the IDP (See Appendix A). PODs were qualitatively evaluated for quality of road construction, reclamation success and general impacts related to surface hydrology. Copies of pictures used for the assessment can be available upon request from the Rawlins BLM Hydrologist.

<u>Northern PODs (Dormant, Red Rim, Jolly A and B)</u> – The farthest northern POD, Dormant, was never developed, a few test wells were put in but it is basically undisturbed.

- The Record of Decision (ROD) for Red Rim was signed in April of 2004 and was drilled mostly in 2004. Many of the areas had not been fully reclaimed by the spring of 2005.
- Pipelines along roads were bermed on the outslope side causing water to pool and hamper reclamation.
- Culverts were generally placed on drainages with very no armoring on the downhill side, this would lead to gullying downstream of the culverts.
- Seeding was generally ineffective due to wind erosion and lack of moisture.
- There were some smashed culverts and generally poor sizing of culverts leading to rilling and gulley formation.
- Weeds were present in many locations, especially at the older Jolly Roger PODs, were interim reclamation was generally unsuccessful.
- Road ROWs had signs of rillling due to inadequate reclamation.
- Some of the newer roads had inadequate drainage features such as wing ditches and culverts leading to gully formation in the ditches along the roads.
- Most of the poorer examples of pad sites were on private or fee land and therefore it should not be assumed that BLM standards will apply to all types of land ownership.

<u>Middle PODs (Doty Mountain, Blue Sky, Sun Dog and Cow Creek)</u> – Doty Mountain is in generally steeper terrain and was drilled mostly in late 2004 and therefore was not reclaimed in April of 2005. Sun Dog, Blue Sky and Cow Creek are generally older, although have had some recent inflill.

- Many of the PODs without reclamation were showing riling and gullying in response to snow melt from the pad sites.
- Some culverts were improperly placed and have silted in.
- Many of the roads were inadequately designed for drainage features and have excessive erosion in ditches and around culverts. Some of these features have been subsequently fixed however there are still plenty of problems to fix as of October 2005.
- Cow Creek POD has problems with pump leaks on one of the fee wells that is forming a gulley, they have inadequate road surfacing, not enough road drainage features and some poor reclamation.
- Sun dog POD is in some poor vegetation that has made reclamation difficult. Prairie dogs have been burrowing into road surfaces and many of the areas have had very poor reclamation.
- There were some smashed culverts and there were not graveled surfaces for the turnaround for trucks visiting the sites.
- Wind rows and berms along roads have interfered with road drainages. Some areas have not been successfully recontoured.
- The pad for 12-8 is closer to Dry Cow Creek than the avoidance area of 500 feet. Gullies have formed that go directly into the drainage complete with a glory hole eating into the pad surface.
- Blue sky POD has had virtually no reclamation along the road ROWs, due to the poor soils, this can be seen from the greasewood. Efforts have largely left these areas as denuded, with exception of weed, and they are rilling and forming gullies in the road ditches.
- There are plenty of fresh tire tracks on areas that are suppose to be reclaimed. Some of the well heads are leaking.
- Compressor sites have generally poor reclamation and have weeds.

Southern PODs (Brown Cow and Muddy Mountain) – Muddy Mountain POD has not been drilled, and only half of Brown Cow has been drilled.

3.4.5.5 Surface Discharge of Produced Water at the Cow Creek POD

This project does not propose any surface discharge of produced water from non-federal leases into facilities on private land, it is therefore assumed all water produced from the coal formation would be re-injected with the exception of off-set uses for flowing wells as described for Cow Creek. Surface discharge at the Cow Creek POD can be expected to continue through the life of the project according to the WYPDES permit # WY0042145 and #WY0035858 which allows for 1.34 tons/day and 180,600 gallons/day of total discharge under both permits.

As an offset for an oil well (as defined by the Colorado River Salinity Control Forum) and the permit allows for the same volume of water and salt as was discharged by the oil well plugged (1x-12). This discharge is in to a reservoir on Dry Cow Creek; this reservoir would be improved and maintained according to this use. The discharge permit is currently being modified to allow for water releases from the reservoir in a similar manner as what occurred historically when 1X-12 was in operation; however volume restrictions would still be in place. The permit would have a new point of compliance upstream of the confluence with Cow Creek. This point of compliance would be monitored for flow, according to the permit it should only have water during storm events, i.e. in response to natural precipitation and not a result of project discharges.

3.4.6 Groundwater

The ARPA occurs in the Colorado Plateau and Wyoming Basin groundwater regions described by Heath (1984), the Upper Colorado River Basin groundwater region described by Freethey (1987), or Washakie Basin described by Collentine et al. (1981) and Welder and McGreevy (1966). Groundwater resources include deep and shallow, confined and unconfined aquifers. Site-specific groundwater data for the ARPA are limited. Existing information comes primarily from oil and gas well records from the Wyoming Oil and Gas Conservation Commission, water-well records from the Wyoming SEO, from the USGS (Weigel 1987), and from the Wyoming SEO, from the USGS (Weigel 1987), from existing CBNG producing wells, and from three monitoring wells drilled to monitor pressures in producing coals and sandstone zones above and below these coals.

Regional aquifer systems pertinent to the ARPA are discussed by Heath (1984), Freethey (1987), and Driver et al. (1984). Basin-wide evaluations of hydrogeology specific to the ARPA have been investigated by Collentine et al. (1981). The most relevant hydrogeologic study specific to the ARPA is by Welder and McGreevy (1966).

3.4.6.1 Location and Quantity

Groundwater in the Washakie Basin is generally found in deep artesian aquifers, in unconfined Tertiary deposits, alluvial deposits and in isolated, saturated outcrops (Welder and McGreevy 1966). Table 3-21 summarizes the water-bearing characteristics of the geologic formations present in the project vicinity. Of the geologic units listed in the table, Welder and McGreevy (1966) suggest that those capable of producing the greatest quantity of water include the following: Quaternary alluvium; Tertiary deposits in the North Park, Browns Park, Wasatch, and Fort Union Formations; Cretaceous formations, including Mesaverde, Frontier, and Cloverly; the Sundance-Nugget Sandstone of the Jurassic Age; and the Tensleep and Madison Formations of the Paleozoic Era.

Following is a brief description of the major aquifers of the ARPA.

Quaternary aquifers in the Washakie Basin are comprised of alluvial deposits along major floodplains and isolated windblown and lake sediments. The major Quaternary aquifers in the vicinity of the ARPA occur in alluvial deposits along the Little Snake River and Muddy Creek, and in windblown segments along the Sand Hills. Groundwater flow within the sandy Quaternary aquifers is typically downward toward permeable underlying formations (Collentine et al. 1981). Ephemeral and intermittent drainages also often contain groundwater in the associated unconsolidated valley fills. Incised drainages serve as capture areas for eolian sand in reaches perpendicular with the prevailing winds. The sand-choked drainages favor rapid infiltration of rainfall and snowmelt leading to contact springs and seeps where groundwater perched in sandy surficial deposits escapes along contacts with less permeable bedrock.

Tertiary aquifers in the ARPA occur in the extensive North Park Formation east of the ARPA, the Browns Park Formation along the Little Snake River flood plain and adjacent to the Sierra Madre Uplift, the Fort Union Formation near the Muddy Creek flood plain to the west, and isolated Wasatch Formation outcrops in the center of the ARPA. Aquifers near the surface are recharged from direct downward percolation of precipitation and snowmelt and from seepage losses from streams. Deep aquifers are also recharged by these processes in outcrop and subcrop areas and from slow leakage from overlying and underlying aquifers. The extent of the Browns Park and North Park units above the eroded, dipping Cretaceous units indicates a

Table 3-21. Water-bearing characteristics of geologic formations in the Washakie Basin.

Era	Period	Geologic Unit	Thickness	Hydrologic Properties		
				Well Yield (gpm)	Transmissivity (gpd/ft)	Permeability (gpd/ft^2)
Cenzoic	Quaternary		0-70	<30	168-560	21-62
		North Park Fm.				
	Tertiary	Browns Park Fm.	0-1,200	3-30	100-10,000	NM
		Wasatch Fm.	0-4,000+	30-50	150-10,000	0.04-18.2
		Fort Union Fm.	0-2,700+	3-300	<2,500	<1
Mesozoic	Upper Cretaceous	Lance Fm.	0-4,500+	<25	<20	0.007-8.2
		Fox Hills Sandstóne	0-400	NM	10-20	0.9
		Lewis Shale	0-2,700+	2-252	0.03-50	0.002-0.9
		Almond Fm. (Mesaverde Group)	0-600	NM	2,000-8,000[1]	100-800[1]
		Mesaverde Group (excl. Almond Fm.)	300-2,800	<100	<3,000	NM
		Baxter Shale (incl. Steele Shale and Niobrara Fm.)	2,000-5,000+	Major regional aquitard between Mesaverde and Frontier aquifers. Hydrologic data unavailable.		
		Frontier Fm.	190-1,1900+	1-100+	<100-6,500	NM
	Lower Cretaceous	Mowry Shale	150-525	Regional aquitard. Hydrologic data unavailable.		
		Thermopolis Shale (incl. Muddy Sandstone)	20-235	Considered a leaking confining unit. Hydrologic data unavailable.		
		Cloverly Fm.	45-240	25-120	340-1,700	1-177
	Upper Jurassic	Morrison Fm.	170-450+	Confining unit between Cloverly and Sundance-Nugget aquifers. Hydrologic data unavailable.		
		Sundance Fm.	130-450+	27-35	12-3,500	NM
	Lower Jurassic-Upper Triassic	Nugget Sandstone	0-650+	35-200	<2,166	NM
	Triassic	Chugwater Fm.	900-1,500+	Confining unit between Sundance-Nugget and Paleozoic aquifers. Hydrologic data unavailable.		
Mesozoic-Paleozoic	Lower Trassic Permian	Phosphoria Fm. (incl. Goose Egg Fm.)	170-460	Probable poor water-bearing capabilities due to low permeability. Hydrologic data unavailable.		
Paleozoic	Permian-Pennsylvanian	Tensleep Fm.	0-840+	24-400	1-374	NM
	Lower and Middle Pennsylvanian	Amsden Fm.	2-260+	Probable poor water-bearing capabilities due to predominance of fine-grained sediments.		
	Mississippian	Madison Limestone	5-325+	<400	Variable	NM
Paleozoic	Cambrian	Indef. rocks	0-800+	4-250	NM	NM
Precam-brian	N/A	Igneous and metamorphic rocks	Unknown	10-20	1<1,000	Generally high in upper 200 ft of unit

Adapted from Table V-1 in Collentine et al. (1981). Formations not encountered in ARPA have been omitted.[1] From Atlantic Rim CBNG well test data.

probable significant recharge area of the underlying permeable units of the Mesaverde Group rocks of the ARPA.

The Mesaverde Group aquifers generally are deeply buried in the ARPA. Although the ability of moderate pumping to readily affect recharge and discharge of the system is somewhat limited, significant groundwater withdrawals from these units would result in large water-level declines that could eventually propagate updip into overlying unconfined Tertiary units. The proposed CBNG development is targeted principally at coal beds contained in the Almond Formation member of the late Cretaceous Mesaverde Group. The terrestrial, sandy, marginal marine Almond Formation is composed of a wide variety of heterogeneous rock types. Single, thick, widespread aquifers having uniform porosity and permeability characteristics are probably not present (Welder and McGreevy 1966). Because individual coal beds are not expected to persist for great distances laterally, drawdowns associated with CBNG well dewatering are expected to be concentrated near individual wells. Coal beds in the Mesaverde Group formations are effectively isolated from the closest adjacent aquifers by the overlying Lewis Shale and the underlying Steel or Baxter Shale confining units. Leakage across these thick sequences of marine clays is considered insignificant.

Groundwater generally flows west-southwest from the higher elevations along the Sierra Madre Uplift toward the low-lying Washakie Basin center and the major streams (Collentine et al. 1981). It would be prudent to obtain quarterly water levels from a few selected wells completed in the Almond Fm., the Brown Park Fm., and the Little Snake River Alluvium between Dixon and Savory prior to development to establish baseline conditions and to demonstrate natural climatic variations and patterns of irrigation usage.

A number of small displacements, generally east-west trending normal faults have been recognized in upper cretaceous and Lower Tertiary rocks within the ARPA. Not all fault zones are conduits to groundwater flow. Fault zones filled with clay or that have become sealed with silica or other minerals may be practically impermeable, where as those filed with crushed rock fragments can be extremely permeable. Some faults permit groundwater to circulate to great depths where it can become heated by geothermal heat sources (Groundwater Atlas (HA730-I)).

Separated from the upper Cretaceous aquifers by the impermeable Morrison Formation is the Sundance-Nugget Aquifer of the Jurassic Age. The Sundance-Nugget aquifer is comprised of permeable sandstone with minor quantities of shale, siltstone, and limestone (Collentine et al. 1981). The flow characteristics of the Sundance-Nugget aquifer are not well defined.

The final two major aquifers occur in Paleozoic Era rocks. The Tensleep Formation from the Pennsylvania Age consists of fine- to medium-grained sandstone between confining layers of the Chugwater Formation (Triassic) and the Amsden Formation (Pennsylvanian) (Collentine et al. 1981). The Madison aquifer is comprised of limestone and dolomite bordered on the top by the fine-grained Amsden Formation sediments and on the bottom by Cambrian rocks. Early Paleozoic rocks are notably absent from far southeast Wyoming and extremely thin on the west flank of the Sierra Madre uplift east of the ARPA. The zero isopach line for these Paleozoic units lies across and north of the Sierra Madre uplift indicating either non-deposition or erosion and complete removal of these units across the ancestral uplift prior to deposition of Mesozoic and Cenozoic rocks. The truncated edge of the Cambrian and Mississippian rocks lies immediately east of the ARPA according to Blackstone (1963). Wells completed within both of these Paleozoic aquifers, where present and of significant thickness, have demonstrated yields up to 400 gpm. Groundwater flow is west-southwest in the ARPA.

Driver et al. (1984) suggest that the Browns Park Formation would be the best candidate for large-scale groundwater development. Recharge to the aquifer is generally by precipitation and surface water seepage percolating through permeable overlying materials (Welder and McGreevy 1966). The major discharge channels, evaporation, and seepage to surface water generally offset the recharge such that groundwater levels are relatively stable (Welder and McGreevy 1966).

An SEO records review revealed 90 permitted non-CBNG wells and springs in the ARPA. Nine of the water rights are filed on springs. They are apportioned as follows: two domestic, six domestic/stock, 52 stock, one stock/irrigation, two stock/miscellaneous, one industrial, and 26 monitoring wells. Of the 90 permitted wells and springs, 58 reported positive yields. Geologic units and yields of the 58 wells are listed in Table 3-22. The majority of these wells were developed in the Mesaverde Group and the Browns Park Formation.

Table 3-22. Existing groundwater wells in ARPA vicinity.

Formation	Number of Wells	Yield[1] (gpm)
Browns Park Formation	12	1-25
Fort Union Formation	1	11
Lance Formation	6	1-25
Fox Hills Sandstone	2	10-15
Lewis Shale	12	3-25
Mesaverde Group	25	1-500

[1] Obtained from SEO well completion permits

3.4.6.2 Quality

Groundwater quality is related to the depth of the aquifers, flow between aquifers, rock type and length of time groundwater is in contact with the enclosing rock type. Dissolved mineral content generally increases with time. Circulation in deeply buried aquifers is generally sluggish; as such, many confined aquifers contain slightly saline to very saline water at depth. Groundwater quality is variable in the ARPA. TDS, an indicator of salinity, is generally less than 2,000 mg/l (slightly saline to saline) in the ARPA, with occasional local concentrations of less than 500 mg/l (considered fresh). Elevated TDS is caused by a variety of factors, including evapotranspiration, mixing of adjacent aquifers, the presence of soluble material, and restriction of flow by faults or impermeable formations.

Because most existing groundwater wells and the proposed CBNG wells of the Atlantic Rim project occur in Mesaverde aquifers, a detailed Mesaverde groundwater quality analysis has been included. Table 3-23 lists the major ionic composition of Mesaverde groundwater in the ARPA. Sodium and bicarbonate dominate as the major ionic species. Collentine et al. (1981) offer three possible explanations for this dominance: (1) exchange of dissolved calcium for sodium; (2) sulfate reduction resulting in bicarbonate generation; and (3) intermixing of sodium-rich, saline water from low-permeability zones within the Mesaverde or adjacent aquifers.

Table 3-23. Major ionic composition of Mesaverde Formation groundwater.

Cation	Concentration (mg/l)	Anion	Concentration (mg/l)
Sodium	513	Bicarbonate[2]	1,284
Calcium	7	Carbonate[1]	9
Magnesium	3	Chloride	56
Potassium[1]	5	Sulfate	11

[1] Potassium and carbonate concentrations were not measured in CBNG samples; values represent composite of USGS data for Mesaverde wells in project vicinity (USGS, 1980).
[2] Bicarbonate was not measured; value shown was calculated from ion balance.

In addition to conventional inorganic analysis, isotopic analysis has been performed on groundwater collected from numerous wells constructed within the interim drilling PODs. Groundwater samples from eight CBNG wells were analyzed for tritium, a radioactive isotope of hydrogen, and deuterium and ^{18}O stable isotopes of hydrogen and oxygen. The absence of tritium in groundwater is indicative of water that was isolated from the atmosphere prior to the early 1950s when large amounts of tritium were introduced into the environment through testing of nuclear devices in the atmosphere (Faure 1986). The tritium content of the eight samples indicates pre-1950s recharge. Further, the isotopic ratios of ^{18}O and deuterium indicate that the groundwater was isolated from the atmosphere when the mean temperature was approximately 10 degrees cooler than the present. Since temperatures this low are associated with the Pleistocene Epoch, which ended approximately 10,000 years ago, this information suggests that groundwater flow through the Mesaverde Group coals is sluggish and apparently not closely connected to nearby surface water supplies. Table 3-24 presents the results of isotope analysis.

Table 3-24. Isotopic analysis of Mesaverde Formation coal seam groundwater.

Well	Tritium Content (TU)	$\delta\,^{18}O_{smow}$ (‰)	$\delta\,D_{smow}$ (‰)
Fed. 1691-16-8	<0.34	-19.32	-145.5
AR Fee 1791 231 Haystack Mtns	<0.50	-19.70	-148.4
AR Fee 1791 231 Deep Creek	<0.60	-19.60	-145.8
AR Fee 1791 231 Cherokee Creek	<0.60	-19.49	-146.7
AR Fee 1791 3-23	<0.50	-18.85	-141.7
AR Federal 1591 9I	<0.50	-19.39	-144.4
AR Fee 1890 SE9	<0.50	-19.74	-148.5
AR Federal 1591-7-8 Blue Sky	<0.60	-19.20	-142.9

T.U. = Tritium Unit. One TU is defined as one tritium atom per 1,018 hydrogen atoms.
SMOW = an international standard used for oxygen and hydrogen isotopic analysis.
0/00 is per mil or per thousand

Table 3-25 presents a comparison of Mesaverde groundwater with WDEQ use suitability standards. The composite results of the three CBNG wells analyzed indicate water that is generally suitable for livestock use, but is unsuitable for domestic supply or irrigation without treatment or dilution. Parameters with measured concentrations in excess of Wyoming drinking water standards include iron, manganese, and TDS. Calculated SAR (47.3) and residual sodium carbonate (41 meq/l) exceed the agriculture suitability limits of 8 and 1.25, respectively. Unless the water was mixed with an existing water source of lower sodium and bicarbonate and lower total salinity, irrigation could result in reduction in infiltration in the affected soil.

The confining beds slow the movement of water, and hence, movement of potential contaminants between aquifers. Although there is some downward movement of the water from the surface units, most of the groundwater movement, if any, is upward from the deeper aquifers to the shallower aquifers. Concerns have been raised for several gas field projects in southwest Wyoming regarding groundwater quality degradation due to the piercing of confining layers and vertical and horizontal migration and mixing of water of variable qualities. Data suggesting this is a current problem in the ARPA are not available. Improperly completed injection wells could be a potential source of contamination. The integrity of the annular seals of existing water supply wells is also crucial in preventing groundwater mixing where multiple aquifers are penetrated.

3.4.6.3 Springs and Flowing Wells

The project area contains numerous springs and flowing wells, which are important local water sources for livestock and wildlife. This area has had extensive exploratory development for natural gas and oil. There has also been monitoring wells installed to evaluated groundwater resources by the USGS and also private firms to evaluate potential coal mining (HSI, 1981). Some of these wells have developed casing leaks, were not plugged properly, or can be used still for monitoring.

The springs occur at two distinct geologic horizons; at the contact between the Tertiary Browns Park Formation and the underlying Upper Cretaceous Mesaverde Group, and within the Mesaverde Group itself. Springs located at the Browns Park Formation/Mesaverde Group are far more common and generally have higher yields than those issuing from units within the Mesaverde Group. The waters from the two spring types have distinctly different chemical signatures: water from the Browns Park Formation springs is low in TDS, enriched in silica, and of the calcium bicarbonate type, while water from the Mesaverde Group springs is higher in TDS, with lower silica concentrations, and of the calcium sulfate type. Table 3-26 presents a comparison of the two water types. Appendix M: Sampled Springs and Flowing Wells depicts the locations of the springs that were sampled to create Table 3-26. Based on water rights information available from the SEO, four of the sampled springs (S-2, S-3, S-4, and S-7) may possess valid water rights.

Table 3-25. Groundwater quality for Mesaverde wells in the ARPA.

Parameter	Concentration[1]	Unit	Groundwater Suitability Standards[2]		
			Domestic	Agriculture	Livestock
Aluminum	0.045	mg/l	---	5	5
Ammonia	0.9	mg/l	0.5	---	---
Arsenic	0.0006	mg/l	0.05	0.1	0.2
Barium	0.36	mg/l	1	---	---
Beryllium	<0.002	mg/l	---	0.1	---
Boron	0.25	mg/l	0.75	0.75	5
Cadmium	<0.0002	mg/l	0.01	0.01	0.05
Chloride	56	mg/l	250	100	2000
Chromium	0.002	mg/l	0.05	0.1	0.05
Cobalt	NM	mg/l	---	0.05	1
Copper	0.03	mg/l	1	0.2	0.5
Cyanide	<5	mg/l	0.2	---	---
Fluoride	1.0	mg/l	1.4 - 2.4	---	---
Hydrogen Sulfide	NM	mg/l	0.05	---	---
Iron	3.06	mg/l	0.3	5	---
Lead	0.004	mg/l	0.05	5	0.1
Lithium	NM	mg/l	---	2.5	---
Manganese	0.[illegible]02	mg/l	0.05	0.2	---
Mercury	<0.0004	mg/l	0.002	---	0.00005
Nickel	0.041	mg/l	---	0.2	---
Nitrate	<0.03	mg/l	10	---	---
Nitrite	<0.03	mg/l	1	---	10
Oil & Grease[3]	<1	mg/l	Virtually Free	10	10
Phenol	56	mg/l	0.001	---	---
Selenium	<0.005	mg/l	0.01	0.02	0.05
Silver	<0.003	mg/l	0.05	---	---
Sulfate	11	mg/l	250	200	3000
TDS	1,322	mg/l	500	2000	5000
Uranium	NM	mg/l	5	5	5
Vanadium	NM	mg/l	---	0.1	0.1
Zinc	0.3	mg/l	5	2	25
pH	8.2	s.u.	6.5 - 9.0	4.5 - 9.0	6.5 - 8.5
SAR	47.3	<none>	---	8	---
RSC[4]	41	meq/l	---	1.25	---
Radium 226 + Radium 228	0.9	pCi/l	5	5	5
Strontium 90	NM	pCi/l	8	8	8
Gross alpha	NM	pCi/l	15	15	15

1 Boron, ammonia, fluoride, and nitrate/nitrite concentrations from 11 Mesaverde groundwater wells (USGS, 1980); remaining concentrations from three Mesaverde CBNG wells in the ARPA.
2 From WDEQ Water Quality Rules and Regulations, Chapter VIII.
3 Reported as total petroleum hydrocarbons.
4 Residual sodium carbonate calculated from measured calcium and magnesium concentrations and calculated bicarbonate concentration.

Two of the sampled flowing wells may have valid water rights (7 Art cot 2N and 7 Art cot 2S). Discharge from the wells contributes to wildlife habitat, furnishing water that over time has created a wetland habitat around the wells. Under direction of the NRCS, water quality sampling and analysis has been conducted on many of the flowing wells. The water type of these wells is of the sodium-bicarbonate type, which indicates water from coal seam aquifers. Groundwater associated with methane production is rich in the anion bicarbonate and almost devoid of the cations calcium and magnesium, but exhibit high concentrations of sodium

(VanVoast 2003). Table 3-27 compares water quality parameters from the flowing wells and that from wells completed in the Almond Formation coal seams. The locations of the flowing wells are depicted in Appendix M.

Table 3-26. Comparison of selected water quality parameters between springs of the Browns Park Formation and of the Mesaverde Group.

Spring Name	Geology	TDS (mg/l)	Silica (mg/l)	Water Type
S-2	Browns Park	330	18.1	calcium bicarbonate
S-3	Browns Park	210	14.9	calcium bicarbonate
S-4	Browns Park	290	11.0	calcium bicarbonate
S-7	Browns Park	329	18.0	calcium bicarbonate
WWCR-1	Mesaverde	1,030	8.1	calcium sulfate
S-5	Mesaverde	1,350	5.8	calcium sulfate
S-6	Mesaverde	1,140	5.4	calcium sulfate

Table 3-27. Comparison of selected water quality parameters in flowing wells and wells completed in the Almond Formation coal seam.

Well Name	Well Type	TDS (meq/l)	Na (meq/l)	Ca (meq/l)	HCO_3 (meq/l)	SO_4 (meq/l)
Duck Flow 2	Flowing	1,230	22.18	0.2	18.03	1.29
7 Art cot 2N	Flowing	496	6.96	1.3	7.05	1.39
7 Art cot 2S	Flowing	596	12.18	0.09	10.32	0.01
AR Fed 1691-16-8	CBNG	1,428	23.4	0.34	19.83	0.04
S & W State 1390 12-36	CBNG	1,900	32.49	0.046	31.14	ND

3.5 VEGETATION

3.5.1 Introduction

The ARPA lies within the Wyoming Basin (Level III) ecoregion, and in the further defined Rolling Sagebrush Steppe (Level IV) ecoregion (USEPA, 2003: Omernik, 1987). The semiarid Rolling Sagebrush Steppe is a vast region of rolling plains and basins, interspersed with uplifts, rims, terraces, and closer to foothills, alluvial fans, draws and drainages. Precipitation and soil parent material are the primary variables controlling plant species distribution, composition, cover and annual production.

Annual average precipitation ranges from 8 inches in the middle of the project area to around 12 inches at higher elevations at the north and south ends. Wind redistribution of winter snow onto north and east slopes may increase these levels by several inches. Most precipitation occurs from March through June as spring snow and summer rain. These all result in the Rawlins area falling between the Intermountain and Great Plains ecotone regions, which is reflected in the vegetative composition observed. The range in soils from sands to clays also adds tremendously to the diversity of vegetation.

A vegetation community map of the project area was created from local data and ground observations. Two principle cover types dominate the vegetation in the ARPA, mountain big sagebrush (50%) and Wyoming big sagebrush (34%). Other cover types include (in order of abundance): alkali sagebrush, mountain big sagebrush/bitterbrush, basin big sagebrush, mountain big sagebrush/mountain shrub mix, juniper woodland, and Wyoming big sagebrush/bitterbrush. Other cover types found in very low amounts include: aspen, badlands, greasewood, greasewood/basin big sagebrush, true mountain mahogany, serviceberry, saltbush steppe, silver sagebrush/bitterbrush, and willow-waterbirch and grassland riparian. The approximate boundaries of these cover types are shown in Appendix M: Vegetation Communities.

3.5.2 Primary Vegetation Cover Types

All principle cover types are described in the following sections except for badlands, which are mostly devoid of vegetation and not typified by any particular species.

3.5.2.1 Mountain Big Sagebrush Cover Type and Subtype Inclusions

This type of big sagebrush is found on about 136,000 acres or 50 percent of the project area. In the past, studies have identified Artemisia tridentata spp. vaseyana as mountain big sagebrush. However, the newer literature (Goodrich et al. 1999, Tart and Winward 1996) recognizes two separate varieties of this subspecies, vaseyana and pauciflora. Numerous field investigations have found these two varieties are morphologically similar in form and commonly found intermixed in the same habitat. Therefore, in the ARPA it has all been mapped as mountain big sagebrush, and will be referred to as ATV.

ATV is generally found around 7,000 feet and higher elevations. It appears as a multi-branched shrub, similar to Wyoming big sagebrush (Artemisia tridentata spp. Wyomingensis (ATW)), with varying height and cover. On wind blown ridges with shallow soils, ATV is sparse in cover and only six to eight inches tall. However, on moderately deep loamy soils with higher moisture levels it may have canopy cover in excess of fifty percent and may reach three feet in height. It is a palatable species for browsing, but due to the elevation it occurs at, is typically only used on a transitional basis to and from winter habitat, and often shows only light to moderate browsing use.

Common grass species associated with the mountain big sagebrush type include thickspike wheatgrass (Elymus macrourus), bluebunch wheatgrass (Pseudoroegneria spicata), little bluegrass (Poa secunda), needle-and-thread (Hesperostipa comata), bottlebrush Squirreltail (Elymus elymoides), prairie Junegrass (Koeleria cristata), mutton bluegrass (Poa fendleriana), green needlegrass (Nassella viridula), oniongrass (Melica bulbosa), Idaho fescue (Festuca idahoensis) and spike fescue (Leucopoa kingii). Common understory shrubs include rabbitbrushes (Chrysothamnus spp.) and snowberry (Symphoricarpos oreophilus), with lesser amounts of bitterbrush (Purshia tridentata) and serviceberry (Amelanchier alnifolia). Due to the higher precipitation on these sites, forbs are diverse and very abundant. Frequently observed species include: silky lupine (Lupinus sericeus), and arrowleaf balsamroot (Balsamorhiza sagittata) intermixed with ATW on rocky, shallow slopes and ridges.

ATV/mountain shrub mix cover type is similar to the Mountain Big Sagebrush described above, with the distinction that mountain shrub species comprise five percent or more of the canopy cover. It comprises about 6 percent of the project area, or approximately 15,000 acres. In the area bordering the sandhills, the mountain shrub component is dominated by bitterbrush.

However, on the south sides of Muddy Mountain and Browns Hill, there is a mixture of bitterbrush, serviceberry, and snowberry; on rocky, shallow soils, true mountain mahogany (Cercocarpos montanus) can also be found. On the north and east slopes of Muddy Mountain, where snow deposition occurs, sites are moister and support a wider variety of species than described above, including: chokecherry (Prunus virginiana) and scattered aspen (Populus tremuloides) in the overstory, elk sedge (Carex geyeri), Ross' sedge (Carex rossii), arrowleaf balsamroot, bluebells (Mertensia spp.), Indian paintbrush (Castilleja spp.), sego lily (Calochortus nuttallianum), false dandelion (Agoseris glauca), locoweed (Astragalus spp.), buttercup (Ranunculus spp.), wild onion (Allium spp.), beardtongue (Penstemon spp.), groundsel (Senecio spp.), phlox (Phlox multiflora), sulfur buckwheat (Eriogonum umbellatum), black sagebrush (Artemisia nova), mountain brome (Bromus anomalus), elkweed (Frasera speciosa), geranium (Geranium richardsonii), bedstraw (Galium boreale), and Oregon grape (Berberis repens).

These sites are important to a wide variety of wildlife for the habitat they provide, but particularly as forage and hiding cover for mule deer and as forage, nesting and brood rearing, and roosting areas for Columbian sharp-tailed grouse. The more moist sites are not as prone to burn as drier sites, but the fuel loads in these communities will burn in wildfires or prescribed burns under the right conditions. Recovery by most species is usually good, especially by snowberry, chokecherry and true mountain mahogany. But bitterbrush, and to a lesser extent serviceberry, can be more susceptible to death loss when fires occur during the summer months.

Wildfires and prescribed burns both occur in the ATV cover type. Without rest or post-burn grazing management, sagebrush cover may return to pre-treatment levels in twenty years. However, monitoring of prescribed burns with rest or deferment after treatment indicates sagebrush recovery may take up to fifty years to reach pre-treatment levels. Under this management, grasses and forbs are allowed to dominate the site initially, reducing the ability of sagebrush seedlings to establish themselves and out-compete other vegetation. The higher amount of moisture on these sites increases their productivity, and response to reclamation should be good (most previous reclamation efforts in this type have not been).

3.5.2.2 Wyoming Big Sagebrush and Wyoming Big Sagebrush/Bitterbrush Cover Types

Wyoming big sagebrush is the shortest subspecies of big sagebrush, but ecologically perhaps the most important. It occupies the more arid environments, generally below 7,000 feet in elevation, and provides critical habitat and forage for species like pronghorn antelope and greater sage-grouse. ATW is second only to ATV in abundance, occupying about 92,300 acres or 34 percent of the project area. Small inclusions of basin big sagebrush, saltbush steppe and greasewood occur within approximately five percent of this area. The height of ATW varies from a few inches tall to over two feet, with more vigorous and denser stands occurring in swales with deeper soils and more precipitation. On open, wind blown sites, which normally have a shallower effective rooting depth, ATW is sparser, smaller in stature, and exhibits lower productivity.

The most common grasses associated with ATW cover type are western wheatgrass (Pascopyrum smithii), thickspike wheatgrass, little bluegrass, bottlebrush squirreltail, needle-and-thread, Indian ricegrass (Achnatherum hymenoides), and threadleaf sedge (Carex filifolia). Douglas (Chrysothamnus viscidiflorus) and rubber (C. nauseosus) rabbitbrush, winterfat (Krascheninnikovia lanata), cotton horsebrush (Tetradymia canescens), prickly-pear cactus (Opuntia polyacantha) and broom snakeweed (Gutierrezia sarothrae) are common understory shrubs. Forbs are less common than in other big sagebrush communities due to the more arid conditions. However, the most frequently observed species include Hood's phlox (Phlox

hoodii), Hooker sandwort (Arenaria hookeri), low buckwheat (Eriogonum ovalifolium), spring parsley (Cymopterus acaulis), locoweeds, goldenweed (Happlopappus spp.), hollyleaf clover (Trifolium gymnocarpum), wild onion, and beardtongue. On gravelly to rocky, shallow hillsides, both bluebunch wheatgrass and black sagebrush are found, in addition to higher amounts of mat forbs. On sites close to the sandhills and sandy soils adjacent to Baggs, bitterbrush co-dominates. Larkspur (Delphinium nuttallianum) and death camus (Zygadenus venenosus) are poisonous plants also occurring in this cover type.

The value of ATW as an important winter browse species cannot be over emphasized. Monitoring transect data from the crucial winter range along Muddy Creek shows severe browse use of ATW during harsh winters, with moderate to heavy use in the transition range to the east that comprises much of the project area. However, during mild winters, transition range browse use remains moderate, while crucial winter range browse use drops to light levels, allowing recovery of crucial winter habitat during more favorable weather periods.

There are very few wildfires and no prescribed burns in ATW habitat due to the sparseness of fuels to carry a fire. Recovery time for ATW to reoccupy a site after a fire occurrence is estimated at 75 to 150 years. Reclamation rates for ATW are also expected to take many years, but are currently unknown.

3.5.2.3 Alkali Sagebrush Cover Type

Alkali sagebrush (Artemisia arbuscula spp. longiloba) is a form of low sagebrush that grows on soils with high clay content. A large portion of these soils occur in the southern portion of the project area from Cherokee Creek south across Deep Creek to Cotttonwood Creek, comprising about 17,100 acres or 6 percent of the total area. Alkali sagebrush grows between 4 and 15 inches tall. Other common species found in this type are western wheatgrass, little and mutton bluegrass, bottlebrush squirreltail, Indian ricegrass, Hood's phlox, false dandelion, hollyleaf clover, penstemon, wild onion, and biscuitroot (Lomatium spp.). Alkali sagebrush is considered palatable as forage, but use appears to be mostly light to moderate; well below use rates for Wyoming big sagebrush. Alkali sagebrush is usually killed by fire and does not resprout. Establishment from seed has been rated as "medium," and establishment from transplants as "very good." Seed production and handling are rated as "medium" because seeds are small. Natural spread by seed and vegetatively is "good."

3.5.2.4 Basin Big Sagebrush Cover Type

Basin big sagebrush (Artemisia tridentata spp. tridentata), hereafter referred to as ATT, occurs on deeper, well drained soils on about 9,200 acres, or 3 percent of the project area. ATT is the dominant vegetation on floodplains bordering riparian habitat, and on ephemeral draws, valley sides, and leeward slopes where there is additional moisture and well developed soils. It is found in association with black greasewood (Sarcobatus vermiculatus) and as small pockets within both ATW and ATV cover types. Basin big sagebrush is the largest sagebrush in this area, with plants on drier sites ranging from three to six feet tall, and plants in floodplains reaching up to ten feet in height. ATT may have taproots up to twenty feet deep, in addition to fibrous roots near the surface to benefit from local precipitation. Palatability of ATT is generally considered lower than ATW (Winward 1993). In fact, observations during winter of 1983-84 along Muddy Creek showed severe use of ATW compared to minimal use of ATT, even though animals were starving and some herd units had 50% die-off.

Common understory species in the ATT type include: thickspike wheatgrass, basin wildrye (Leymus cinereus), little bluegrass, Kentucky bluegrass (Poa pratensis), bluebells (Mertensia spp.), lupine, locoweed, violet (Viola spp.), Louisiana sagewort (Artemisia ludovicianna), aster (Aster spp.), false dandelion (Agoseris spp.), butter cup (Ranunculus spp.), wild onion, groundsel (Senecio spp.), povertyweed (Iva axillaris), wild rose (Rosa woodsii), snowberry, rabbitbrushes, and golden currant (Ribes aureum). On some sites bitterbrush, serviceberry, and/or true mountain mahogany occurs. Since these sites are often close to water, historic and current grazing use is often very common, and in some cases, excessive. Species like Kentucky bluegrass may proliferate while more sensitive species like basin wildrye may decrease in abundance. In addition, species which thrive from disturbance like cheatgrass (Bromus tectorum) become a component of this type.

Wildfires and prescribed burns both occur in this cover type. Where other species are uncommon or without post-burn grazing management, sagebrush cover may return to pre-treatment levels in fifteen to twenty years. However, monitoring of prescribed burns with rest or deferment after treatment indicate ATT recovery may take up to fifty years to reach pre-treatment levels. Under this management, grasses and forbs are allowed to dominate the site initially, reducing the ability of sagebrush seedlings to establish themselves and out-compete other vegetation. The higher amount of moisture on these sites increases their productivity, and response to reclamation should be good (most previous reclamation efforts in this type have not been).

3.5.2.5 Juniper Woodland Cover Type

Utah juniper (Juniperus osteosperma) is the dominant tree in the juniper woodland cover type, which occurs on approximately 9,900 acres or 3 percent of the ARPA. They grow from 8 to 15 feet in height and width. Persistent stands are found on shallow, rocky soils with fractured rock substrate, where the juniper can root down to and take advantage of water that collects in these locations. Juniper will also encroach into adjacent big sagebrush stands. This cover type usually has a sparse to moderate cover of juniper trees over big sagebrush and/or true mountain mahogany. Other common understory species include bluebunch wheatgrass, Indian ricegrass, little bluegrass, Canby bluegrass (Poa canbyi), groundsel, beardtongue, phlox, goldenweed, miners candle (Cryptantha spp.), twin bladderpod (Physaria spp.), and occasionally some bitterbrush and black sagebrush.

Juniper stands occur along the western edge of the project area, adjacent to and within crucial winter range for mule deer. They provide important thermal cover and forage for mule deer and occasionally elk, as well as habitat for a variety of birds and small mammals. The stands of juniper closer to Baggs are "yarding" areas where very high densities of mule deer reside during critical winter periods. When stands of Utah juniper become too dense, the understory of native grasses, forbs and shrubs die out and are replaced with cheatgrass and annual forbs. Fire can be a useful tool in reducing juniper overstory and maintaining understory cover and composition. Where the understory is too sparse to carry a fire, some form of mechanical treatment may be needed to restore species diversity.

3.5.2.6 Aspen Woodland Cover Type

Aspen (*Populus tremuloides*) is the dominant tree in the aspen woodland cover type, which occurs on approximately 434 acres of the ARPA. They grow from five to thirty feet tall at higher elevations (usually above 7000 feet) on north and east slopes where windblown snow accumulates. This provides the moisture and deeper soils necessary to support aspen.

Common understory shrubs include snowberry, serviceberry, creeping juniper (*Juniperus communis*), and Scouler's willow (*Salix scoulerianna*). A variety of grasses and forbs often dominate the understory, with elk sedge and Columbia needlegrass (Achnatherum nelsonii) the most common. Other species include mountain brome, blue wildrye (Elymus glaucus), Kentucky bluegrass, columbine (Aquilegia spp.), waterleaf (Hydrophyllum spp.), bluebells, wild licorice (Glycyrrhiza), bedstraw, heartleaf arnica (Arnica spp.), fairybells (Disporum spp.), Solomons seal (Polygonatum spp.), yampa (Perideridia spp.), and sweet-cicely (Osmorhiza spp.). Many aspen stands are diseased, dying out, and being overtaken by serviceberry, big sagebrush and creeping juniper. The use of fire can often remove competing species and stimulate regeneration. These habitats provide diverse vertical structure for many bird species and forage/hiding cover for mule deer and elk, and support numerous other wildlife species.

3.5.2.7 Greasewood and Greasewood/Basin Big Sagebrush Cover Types

Black greasewood is the dominant species on saline soils along floodplains and ephemeral drainages, particularly along portions of Muddy Creek and Wild Cow Creek. It occupies approximately 3400 acres (1 percent) of the ARPA. This species also encroaches into the big sagebrush and saltbush steppe cover types, taking advantage of where it can find additional moisture. Although considered poisonous, it is often observed being eaten by livestock and big game species. Understory species composition is not as diverse as the big sagebrush cover types, with common species including basin wildrye, western wheatgrass, little bluegrass, bottlebrush squirreltail, inland saltgrass (Distichlis stricta), biscuitroot, wild onion, pepperweed (Lepidium spp.), and Gardner's saltbush (Atriplex gardneri). On some sites there are patches or intermixing with stands of basin big sagebrush.

3.5.2.8 True Mountain Mahogany and Serviceberry Cover Types

True mountain mahogany occurs as the dominant cover on shallow, rocky hillsides, and may be adjacent to juniper woodland. It occurs on approximately 800 acres (less than 1 percent) within the ARPA. Shrubs grow from two to seven feet tall depending on the soils and precipitation. Serviceberry occurs as the dominant cover on shallower soils. It occurs on approximately 100 acres. These species, along with bitterbrush, are highly sought out by mule deer in the fall and winter months. Health of these stands in mule deer winter concentration areas is often very poor with severe browsing on an annual basis. Common understory species are similar to those described for juniper woodlands.

3.5.2.9 Saltbush Steppe Cover Type

Gardner's saltbush is the characteristic species of this cover type, found on upland saline soils in small openings or linear 'stringer' stands within Wyoming big sagebrush or black greasewood cover types. Since most stands of this cover type are too small to delineate from other cover types, the acreage is underestimated, but would still be less than 1 percent of the ARPA if accurately tallied. These stands are sparsely vegetated, with bare soil often exceeding 60 percent of the total surface cover. Plants usually grow four to ten inches in height. Other common species in this cover type are little bluegrass, Indian ricegrass, bottlebrush squirreltail, western wheatgrass, phlox, biscuitroot, wild onion, pepperweed, winterfat, and birdsfoot sagebrush (Artemisia pedatifida). Pronghorn antelope and livestock utilize this species on a year-round basis.

3.5.2.10 Silver Sagebrush/Bitterbrush/Rabbitbrush Cover Type

This cover type occurs on 1500 acres; less than 1 percent of the project area.

3.5.2.11 Riparian Cover Types

Riparian habitat comprises approximately 250 acres within the ARPA along perennial and intermittent drainages and around seeps and springs. Although small in extent, these areas are the most diverse and productive of all vegetated sites, and therefore are extremely important for wildlife habitat and livestock forage. Three different community types can be distinguished in the project area: cottonwood/willow, willow/waterbirch, and grassland.

Cottonwood/willow riparian habitat comprises about 20 percent of the total riparian cover type, and is found in the southern portion of the ARPA along Cottonwood Creek, Youngs Draw and Deep Creek. These drainages are intermittent except below artesian wells along sections of Cottonwood Creek. Narrowleaf cottonwood (Populus angustifolia) may grow up to 50 feet tall and requires scouring runoff events to prepare seedbeds for germination. Coyote willow (Salix exigua) and wild rose are the principle understory shrubs, with basin wildrye, Kentucky bluegrass, inland saltgrass, and thickspike wheatgrass the primary understory grasses.

Willow/waterbirch riparian habitat comprises about 10 percent of the total riparian cover type, and is found along Muddy Creek north of Doty Mountain and along Separation Creek in the northern portion of the ARPA. Although intermittent in the late summer and fall months, these stream reaches are sufficiently wet to support water "loving" species. Shrub species include coyote and yellow (Salix lutea) willow, waterbirch (Betula occidentalis), shrubby cinquefoil (Potentilla fruticosa), wild rose, and golden currant. Willows are usually three to six feet tall, with waterbirch reaching 15 feet in height. Common understory grass or grass-like species are Kentucky bluegrass, inland saltgrass, redtop (Agrostis alba), streambank wheatgrass (Elymus trachycaulum), meadow barley (Hordeum brachyantherum), Baltic rush (Juncus balticus), spike-sedge (Eleocharis spp.), tufted hairgrass (Deschampsia cespitosa), northern reedgrass (Calamagrostis inexpansa), common reed (Phragmites communis), Nebraska sedge (Carex nebraskensis), beaked sedge (Carex rostrata), American bulrush (Scirpus americanus), and pondweed (Potamogeton spp.). Forbs include asters, locoweed, goldenrod (Solidago canadensis), licoriceroot (Glycyrrhiza lepidota), lettuce (Lactuca serriola), mint (Mentha arvensis), willowweed (Epilobium glandulosum), plantain (Plantago eriopoda), and strawberry potentilla (Potentilla anserina).

Grassland riparian habitat is the most common type of riparian plant community in the ARPA, totaling about 70 percent of all riparian cover types. These sites are diverse and composition depends on the quantity and quality of water supporting it. It is common for one or two species to dominate the composition of a particular site. Species are, for the most, part similar to those listed above. Although shrubs are not always present, the principle species, coyote willow, is not usually abundant. Wetter sites, like along Fillmore Creek, Cow Creek and Cherokee Creek contain more sedges. Drier sites, like those found along Dry Cow drainage, Wild Cow Creek and Deep Creek, are dominated by grasses and Baltic rush.

3.5.3 Noxious and Invasive Weeds

On 3 February 1999, Executive Order (EO) 13112 ("Invasive Species") was signed by President Clinton. The primary purpose of this EO is to prevent the introduction of invasive species and provides for their control and to minimize the economic, ecological, and human health impacts

that invasive species cause. In Wyoming, some 428 species have been documented as invasive (Hartman and Nelson 2000). Of these 428 plants, 24 are designated as noxious by the State of Wyoming (Rice 2002) and are shown in Table 3-28. In addition to these 24 state-designated species, Carbon County has designated halogeton (Halogeton glomeratus), plains prickly pear (Opuntia polyacantha), Geyer larkspur (Delphinium geyeri), and lupine (Lupinus spp.)· as noxious (Justesen 2004). Noxious weeds are very aggressive, and invading infestations tend to exclude other native plant species and reduce the overall forage production of desirable shrubs, herbaceous grasses and forbs. The project area is vulnerable to infestations of noxious weeds, especially on newly disturbed surfaces. However, a majority of the project area contains sufficient assemblages of native plants to deter invasive, but not noxious, weed establishment in undisturbed habitat.

Noxious weeds known to occur or that have been treated within the ARPA are Russian knapweed, Canada thistle, whitetop, and musk thistle. Russian knapweed has been treated along the BLM road on the east side of Wild.Horse Butte and occurs by the gate just south of the Morgan Ranch homestead. The first population appears to no longer exist and the second population needs to be field checked. Canada thistle commonly occurs along Muddy Creek, and appears to grow on the eroding banks between the riparian habitat and the upland basin big sagebrush plant community. It has not been a problem and is extensive enough to take a large scale effort to eradicate it. With greater concern for other noxious species, treatment of Canada thistle is currently on hold. Whitetop has only been documented along the county road by Cow Creek and current status needs to be field checked. Musk thistle has also been documented on the east side of Wild Horse Butte.

Halogeton, an invasive weed, has been present in the project area for many years, occurring in disturbed areas such as roadsides, old bedgrounds and corrals. These populations did not appear to be expanding with minimal expansion of disturbed surface areas. However, with expansion of disturbance as a result of the interim drilling for coalbed methane, halogeton has expanded along roads and pipelines with inadequate control treatments and reclamation.

Noxious and invasive species known to occur outside, but adjacent to the project area, include houndstongue, salt cedar, spotted knapweed and black henbane. Houndstongue is common in the Loco Creek and Savery drainages east of the south end of the ARPA. Some locations have been treated but there are too many plants to effectively treat all locations at this time. Salt cedar is found along the middle and lower sections of Muddy Creek. Treatments are planned for the fall of 2005 to eliminate the largest populations above the George Dew homestead, but further treatments would still be required to eradicate all salt cedar plants. Spotted knapweed has shown up from time to time, primarily along highways. A recent discovery documented this species along Highway 789 between milepost markers 10 and 21, and treatments would be planned to control it. Black henbane primarily occurs along roads and pipelines, and has been documented all around the project area along gas field, BLM, and county roads.

Some of these species require disturbance to become established and some do not. What appears to be more critical is the transportation of seeds along highways and roads via vehicles and construction equipment that can only be controlled by more education and/or enforcement for washing of vehicles to reduce the likelihood of seed movement.

Table 3-28. Designated Noxious Weeds in Wyoming.[1]

Scientific Name	Common Name
Agropyron repens	Quackgrass
Ambrosia tomentosa	Skeletonleaf bursage
Arctium minus	Common burdock
Cardaria draba, C. pubescens	Hoary cress, whitetop
Carduus acanthoides	Plumeless thistle
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed
Centaurea maculosa	Spotted knapweed
Centaurea repens	Russian knapweed
Chrysanthemum leucanthemum	Ox-eye daisy
Cirsium arvense	Canada thistle
Convolvulus arvensis	Field bindweed
Cynoglossum officinale	Houndstongue
Euphorbia esula	Leafy spurge
Isatis tinctoria	Dyers woad
Lepidium latifolium	Perennial pepperweed
Linaria dalmatica	Dalmatian toadflax
Linaria vulgaris	Yellow toadflax
Lythrum salicaria	Purple loosestrife
Onopordum acanthium	Scotch thistle
Sonchus arvensis	Perennial sowthistle
Tamarisk spp.	Salt cedar
Hypericum perforatum	Common St. Johnswort
Tanacetum vulgare	Common tansy

[1] Designated Noxious Weeds, Wyoming Stat. § 11-5-102 (a)(xi) and Prohibited Noxious Weeds, Wyoming Stat. § 11-12-104.

3.6 RANGE RESOURCES

The ARPA overlaps 31 BLM grazing allotments (Appendix M: Grazing Allotments), totaling 574,688 acres that are permitted for 39,695 cattle and 7,421 sheep Animal Unit Months (AUMs) (Table 3-29). The season of use for each allotment varies, but most are for spring, summer and/or fall use with pastures for control of season and duration. In many cases, the boundaries of the grazing allotments extend beyond the boundaries of the ARPA. This document will focus on those allotments that are mostly within the ARPA, (listed in the table in bold) unless specifically mentioned.

There are 21 allotments within the ARPA that would be primarily affected by the proposed action or an alternative (30% allotment acres or higher within ARPA). These allotments contain 372,444 acres (64% public) and 30,462 permitted AUMs. Fourteen different livestock operations have permitted use in these allotments, with most having private (single operator) allotments. However, in Cherokee allotment, use is shared between eight permittees. The total AUMs are split into 27,671 cattle AUMs (91%) and 2,791 sheep AUMs (9%), and there is a small amount of use by ranch horses. The total permitted AUMs within these 21 allotments equal about 7.8 acres per AUM across the ARPA.

Table 3-29. Grazing Allotments and Animal Unit Months (AUMs) Currently Permitted in the Atlantic Rim Project Area.[A]

Allotment Name	Total Acres	Allotment % in ARPA	BLM Acres and Permitted AUMs			
			Acres	Cattle AUMs	Sheep AUMs	Total AUMs
Adams Ranch	**199**	**67**	**39**	**6**		**6**
Airheart Pasture	**1861**	**74**	**520**	**96**		**96**
Badwater	21,777	9	10,251	802	399	1,201
Baggs Sub-Unit	**8,411**	**88**	**3,965**	**264**		**264**
Brimmer Pastures	**1,325**	**88**	**291**	**18**		**18**
Bull Canyon	7,688	26	3,833	748		748
Cherokee	**66,799**	**94**	**62,706**	**6,412**	**1,588**	**8,000**
Cottonwood Creek	**5,040**	**100**	**200**	**17**	**17**	**94**
Dad	433	9	433	94		94
Daley Ranch	26,083	13	11,305	959		959
Deep Creek Pasture	**6,172**	**100**	**1,571**	**635**		**635**
Deep Gulch	**35,452**	**60**	**26,954**	**3,597**		**3,597**
Doty Mountain	**84,008**	**67**	**59,504**	**6,976**		**6,976**
East Muddy	**6,154**	**91**	**5,484**	**301**		**301**
Fillmore	**39,923**	**61**	**17,449**	**3,374**		**3,374**
Grizzly	38,091	9	27,533	5,280		5,280
Headquarters Ranch	**612**	**67**	**142**	**25**		**25**
JO Pastures	**1,136**	**100**	**1,136**	**600**		**600**
Morgan-Boyer	11,163	9	8,260	1,002	700	1,702
Morgan Ranch	**4,930**	**100**	**2,780**	**263**		**263**
North Baggs	741	9	179	18		18
Rasmussen Sub-unit	19,411	11	4,751	792		792
Sixteen Mile	**81,509**	**31**	**37,513**	**2,442**	**1,186**	**3,628**
Smiley Draw	**3,540**	**100**	**1,345**	**226**		**226**
South LaClede	60,436	1	34,328	233	3,531	3,764
South Muddy	**1,562**	**90**	**1,562**	**103**		**103**
South Pasture	**3,880**	**95**	**497**	**96**		**25**
Sulphur Springs	22,752	21	12,832	2,096		2,096

Allotment Name	Total Acres	Allotment % in ARPA	BLM Acres and Permitted AUMs			
			Acres	Cattle AUMs	Sheep AUMs	Total AUMs
West Loco	920	67	120	30		30
West Wild Cow	3,835	100	3,502	437		437
Wild Cow	8,815	59	7,868	1,760		1,760
Totals	574,688		348,096	39,695	7,421	47,116

[A]Allotment Names in bold are those primarily affected and are discussed in text.

Cattle operations are primarily cow/calf pairs, but three allotments (Deep Gulch, Fillmore and JO Pastures) are typically used by yearlings. Use occurs during the spring, summer and/or fall months, depending on the location of the allotment and the requirements of each individual livestock operation. Each allotment is usually used for one season, or longer if use is rotated between pastures. Most ranchers calve at the home place before moving out to an allotment. However, two permittees range calve on their allotments but in pastures outside the area of the ARPA. There are also pastures with corrals essential for shipping. Use periods of these facilities varies by operation, with animals trucked in between April and June, with roundup and trucking out anytime between mid-August to September for yearlings and from October through December for cows and calves.

Sheep use is primarily during May and June for lambing, with lesser amounts of use in late September and October. In addition, sheep trail to and from desert (winter) allotments to lamb, then trail to and from the National Forest where they spend the summer. Cherokee is the principal allotment with active sheep use made by two operators. Lambing in this allotment is primarily in the Cottonwood Creek, Deep Creek, and Wild Cow Creek drainages. However, trailing of sheep occurs across Doty Mountain, East Muddy and Smiley Draw allotments. Corrals or pens for sheep may be permanent, but often are temporary and installed at the location needed to work the sheep. These are usually on the lambing grounds to shear the sheep in late April or early May or to brand, cut and dock the lambs in late May or early June.

Most ranchers have lived and worked within the project are for three to four generations. Their knowledge is extensive, not just pertinent to livestock management, but in local information such as where the snow blows free or collects, when the country opens up or when the ice comes out of the storm channels, and where and wildlife move within allotments. This information is useful in planning and reducing impacts, and ranchers should be encouraged to participate in coordinating long-term development, production and reclamation.

There are currently artesian water wells being relied upon to provide water for livestock. In the Muddy Creek watershed, there have been many cooperative projects between the ranchers, BLM, Little Snake River Conservation District, and others to improve resource management, and more recently to ensure that Standards for Healthy Rangelands are being met. Ranchers have always sought to improve their livestock management, but over the last twenty years there has been more emphasis to achieve this goal. Water developments, fencing, pasture rotations, vegetation treatments, monitoring sites, and other tools are used in range management with the cooperation of livestock operators to improve watershed cover, riparian habitat and upland plant

condition. The benefits of these actions need to continue as new resource uses and development occur within the ARPA and the entire Muddy Creek watershed.

3.7 WILDLIFE AND FISHERIES

3.7.1 Wildlife

3.7.1.1 Introduction

The ARPA is located within the Rawlins Field Office. The project area encompasses 270,080 acres, which is approximately 2.3 percent of the 12-million acre resource area. Information concerning current and historical wildlife locations was obtained from several sources. The Wyoming Game and Fish Department (WGFD) Wildlife Observation System (WOS) contains records of observations for all types of wildlife (birds, mammals, reptiles, and amphibians) (WGFD 2003a). The Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming (WGFD 1999) was also used to assess the potential occurrence of species in the project area. This atlas divides Wyoming into 28 degree blocks, and the presence or absence and breeding activity of vertebrate species are documented by degree block. The ARPA is located in degree block 25. Annual big game herd unit reports from the WGFD Green River and Lander regions were used to determine big game herd unit boundaries, population objectives, seasonal ranges, and migration routes. Location records for vertebrate species of special concern, within an approximate 6-mile buffer of the project area, were obtained from the Wyoming Natural Diversity Database (WYNDD 2003). Greater sage-grouse lek and raptor nest locations were obtained from the WGFD and Rawlins, Wyoming, BLM Field Office.

3.7.1.2 Wildlife Habitat

A wide variety of wildlife habitats and their associated species occurs on the project area. Wildlife habitats that could be affected by the project include both the areas that would be physically disturbed by the construction of the gas wells, related roads, pipelines, and production facilities as well as zones of influence surrounding them. Zones of influence are defined as those areas surrounding, or associated with, project activities where impacts to a given species or its habitat could occur. The shape and extent of such zones varies with species and circumstances.

General vegetative species composition for each habitat type is characterized in Section 3.5.2 of this document.

3.7.1.3 General Wildlife

A total of 338 species have been recorded, or may occur, within the project area and surrounding region, either as residents or migrants. This species list (Appendix D) includes 248 birds, 73 mammals, and 11 reptiles, and 6 amphibians. The presence and distribution of these wildlife species were determined from published literature, unpublished data from federal and state agencies, databases from federal and state agencies, and on-site surveys conducted by HWA from 2000 - 2004. Although all of the species are important members of wild land ecosystems and communities, most are common and have wide distributions within the project area, state, and region. Consequently, the relationship of most of these species to the proposed project is not discussed in the same depth as species which are threatened,

endangered, sensitive, of special economic interest, or are otherwise of high interest or unique value.

3.7.1.4 Big Game

Pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) are the big game species that occur on the ARPA. Big game populations are managed by the WGFD within areas designated as herd units and are discussed in that context. The types of big game seasonal ranges designated by WGFD (WGFD 1996) discussed in this document include winter, winter/yearlong, crucial winter, crucial winter/yearlong, and spring/summer/fall. Winter ranges are used by a substantial number of animals during winter months (November through April). Winter/yearlong ranges are occupied throughout the year but during winter they are used by additional animals that migrate from other seasonal ranges. Crucial range (i.e. crucial winter and crucial winter/yearlong) describes any seasonal range or habitat component that has been identified as a determining factor in a population's ability to maintain itself at a specified level (theoretically at or above the population objective) over the long term. Not all habitats within designated crucial winter range are of equal quality. Areas with higher quantity and quality of forage and areas that provide cover from extreme winter weather conditions provide the best quality crucial winter range habitat. Crucial ranges are typically used 8 out of 10 winters. Spring/summer/fall ranges are used before and after winter conditions persist. Areas designated as OUT (or non-use areas) contain habitats of limited or no importance to the species.

Using WGFD information that was averaged from 1997-2001, comparisons can be made about the species richness and productivity across Wyoming. When numbers for antelope, mule deer, and elk are combined for similar-sized geographic units, the harvest data for the Sierra Madre/Snowy Range area (includes the ARPA) within the RFO are similar to the Sublette region around Pinedale, which is considered the most productive big game region in the state. In addition, recreation days and the economic benefits associated with hunting were 50 percent higher for the Sierra Madre/Snowy Range area when compared to the Sublette region (Rawlins Draft RMP 2004).

Pronghorn. The ARPA is located mostly within the 1,394-mi^2 Baggs Herd Unit but also encompasses very small portions of the Bitter Creek and Iron Springs Herd Units (Appendix M: Seasonal pronghorn antelope ranges and migration routes). The project area encompasses 480 mi^2 or 39.7 percent of the Baggs Antelope Herd Unit. The Upper Colorado River Basin Standards and Guidelines Assessment 2002 failed Standard #4, Wildlife Habitat Health, and addressed pronghorn range as follows. The population objective was raised in 1994 from 7,100 to 9,000 animals. Prior to raising this objective, antelope populations had tended to be at or above objective levels in most years. Whether the current herd objective is supportable is not yet known. Principal concerns within the Baggs antelope herd are tied to the 74% winter diet overlap with mule deer, and the high levels of browse use and health of the sagebrush habitat in crucial winter range. The latter is caused by the concentration of animals in the Muddy Creek crucial winter range during severe winters and their inability to move through or under fences along Highway 789. There are 45,549 acres of antelope crucial winter range, of which 24% is on private and state lands where there are no protections against disturbance of animals during critical time periods (Appendix M: Big Game Crucial Winter Ranges). Current trends in this sagebrush community are stable. However, as populations are raised toward the higher population objective and when more severe winter weather returns to this portion of Wyoming, the trend in these communities would have to be closely watched. The transition range located on lower elevations adjacent to crucial winter range is important in receiving more use by

antelope in milder winters and reducing the browsing pressure on the crucial winter range. The importance of big sagebrush to antelope can not be overstated, sagebrush comprised the majority of pronghorn diets (71% in summer and 96% in winter) (Alldredge and Deblinger 1988).

Table 3-30. Population Parameters for Big Game Herd Units within the ARPA.

Species	Herd Unit	Unit No.	Hunt Area(s)	Size (mi^2)	Population Estimate (2003)[c]	Population Objective	Density Estimate Objective[a]	Fawn:Doe Ratio
Pronghorn	Baggs	438	53, 55	1,394	8,900	9,000	6.46	43:100[b]
Pronghorn	Bitter Creek	414	57,58	2,915	12,000	25,000	8.58	36:100[b]
Mule Deer	Baggs	427	82,84, 85,100	3,440	20,500	18,700	5.44	44:100[c]
Elk	Sierra Madre	425	13,14,15, 21,108	2,425	5,100	4,200	1.73	45:100[c]
Elk	Petition	430	124	2,915	300	300	0.10	44:100[c]

[a] = No. Animals (WGFD Population Objective) per Square Mile of Occupied Habitat
[b] = Prehunt Classification
[c] = Posthunt Classification

Table 3-31. Big Game Seasonal Ranges within the Atlantic Rim Project Area.

	Seasonal Range[1] Areas (acres)						
	CWIN	CWYL	WIN	WYL	SSF	OUT	UND
Pronghorn	-	45,549	-	156,405	72,176	-	-
Mule Deer	894	73,598	-	187,815	11,824	-	-
Elk	-	40,745	197,294	16,006	-	18,640	1,447

[1]CWIN: Crucial Winter, CWYL: Crucial Winter/Yearlong, WIN: Winter, WYL: Winter/Yearlong, SSF: Spring/Summer/Fall, OUT: Non-use Areas, UND: Undefined Areas.

__Mule Deer.__ The ARPA is located within the eastern portion of the 3,440-mi^2 Baggs Herd Unit (Appendix M: Seasonal mule deer ranges and migration routes). The boundaries for this herd unit correspond with the Bitter Creek Road on the west, Interstate 80 on the north, and the Wyoming/Colorado border on the south. Much of the eastern border follows the Continental Divide until it intersects WH 71.

The 2003 post-hunt population estimate for the Baggs Herd Unit was 20,500, but were previously as high as 27,000 in 1987, prior to a winter die-off in February 1993. This estimate is above the WGFD management objective of 18,700 (Table 3-30). However, this area is one of few in the State of Wyoming which usually supports an any deer harvest to manage deer numbers at objective levels. This is a reflection of the productivity of this deer herd and the quality of spring-summer-fall habitat that supports them. The project area is located within Hunt Areas 82, 84, and 100. Hunt Area 82 remains the most popular in the herd unit and sustains the highest levels of hunter use (WGFD 2003b). Mule deer migrate from the eastern portion of the Baggs Herd Unit to lower elevation crucial winter ranges that are located in the southern and central portions of the ARPA. Some mule deer that spend the summer near the Sandhills may

migrate to winter range in the southwestern portion of the Baggs Herd Unit near Powder Rim (Porter 1999). Of particular importance is the crucial winter range located south and west of

Muddy Mountain within the ARPA. Although many mule deer migrate to other locations, this area becomes a concentration area for mule deer during severe winter conditions.

The Upper Colorado River Basin Standards and Guidelines Assessment (2002) failed Standard #4, Wildlife Habitat Health, and addressed mule deer range as follows. Of the three commonly found big game species in this watershed, deer habitat, and particularly crucial winter range, is of the highest concern. The most concentrated mule deer use occurs from Horse Mountain down to Poison Basin and north along Muddy Creek, at lower elevations. Adjacent to this area and to the north and west are areas in better condition that are used in mild winters but act more as transition habitat in severe winters. The second factor is that a much higher percentage of mule deer crucial winter range is on private lands than compared to antelope and elk crucial winter range. There are 74,492 acres of mule deer crucial winter range (Table 3-31), of which 42% is on private and state lands where there are no protections against disturbance of animals during critical time periods (Appendix M: Big Game Crucial Winter Ranges). Therefore, this should be taken into account (when possible), concerning actions occurring on lands adjacent to public lands and realize that actions taken on public lands would only affect approximately 20% of the most heavily utilized areas within the crucial winter range.

Observed habitat concerns in the mule deer crucial winter range include single species dominance by Utah juniper and big sagebrush species, mature-to-decadent age class structure of all shrub communities, poor vigor and heavy-to-severe utilization of desired shrub species, dense stands of shrubs that inhibit use and movement, and low composition of forbs on deer ranges used first in the spring. The principal area deemed not to be meeting Standard #4 for wildlife habitat is the mule deer crucial winter range located between Horse Mountain and Poison Basin and north from Baggs along Muddy Creek through the Wild Horse and Dad juniper woodlands. This area encompasses about 40,000 acres of public land.

Elk. Most of the ARPA is located within the western portion of the Sierra Madre Herd Unit. Similar to other elk herds in the State of Wyoming, the population of elk in this unit has been above objective levels for many years. However, due to liberal harvests the trend in this herd indicates the population is decreasing towards objective levels (WGFD 2004). The majority of the ARPA is identified as winter range for elk, with crucial winter range identified along the eastern and southern borders. The crucial winter range occurs at lower elevations where less snow accumulates, and on steep, south and west facing slopes that commonly blow free of snow or melt off during winter months. There are 40,745 acres of elk crucial winter range, of which 17% is on private and state lands where there are no protections against disturbance of animals during critical time periods (Appendix M: Big Game Crucial Winter Ranges). A limited amount of summer range is also located along the eastern border in the aspen, sagebrush and riparian habitats. Many elk in the Sierra Madre Herd Unit migrate from the Sierra Madre Range west to crucial winter/yearlong and winter ranges located throughout the ARPA (Appendix M: Seasonal elk ranges and migration routes). Elk diets are similar to cattle, with a preference for grass and forb species, but with increasing amounts of shrubs during the winter. The population of elk in this herd unit is also a reflection on the health of the habitat that supports them. Elk are more sensitive to human activities than pronghorn or mule deer, and they may be displaced from construction areas by 0.75 - 2 miles (Brekke 1988, Gusey 1986, Hiatt and Baker 1981).

Overlapping Big Game Crucial Winter Range. Areas of overlapping big game crucial winter range are of greater importance because they provide crucial habitat for more than one species

of big game. There are several areas of overlapping big game crucial winter range located in the ARPA (Appendix M: Overlapping Crucial Winter Ranges). The combinations of overlapping big game crucial winter ranges include the following: elk/mule deer 3,038 acres; mule deer/antelope 22,637 acres. Forty percent is on private and state lands where there are no protections against disturbance of animals during critical time periods. The impacts of habitat loss within overlapping crucial winter ranges would be greater than in non-overlapping areas. The Great Divide RMP (USDI-BLM 1988) states that habitat quality will be maintained within areas of overlapping big game crucial winter ranges.

3.7.1.5 Upland Game Birds

The WGFD manages upland game birds within upland game management areas. The greater sage-grouse (*Centrocercus urophasianus*) and the Columbian sharp-tailed grouse (*Tympanuchus pahianellus columbianus*) are the main upland game bird species known to occur in the ARPA, which lies within the Sierra Madre Upland Game Management Area (UGMA #25) and includes a very small portion of the Bitter Creek Upland Game Management Area (UGMA #10).

Greater Sage-grouse. Wyoming is one of the last strongholds for greater sage-grouse in the western United States, and contains more grouse than all other states combined. Greater sage-grouse are common throughout Wyoming because their habitat remains relatively intact compared to other states. In south-central Wyoming, this is even more accentuated due to the harsh climate that has limited past habitat loss or conversion to settlements and agricultural development along river bottoms. In the past, disturbance to upland habitats was restricted to livestock grazing and vegetation treatments (primarily at higher elevations). More recent disturbance to grouse habitat has come with development of energy resources.

Greater sage-grouse lek locations were obtained from the WGFD and the RFO. There are 88 leks located in and within two miles of the ARPA (Appendix M: Greater sage-grouse leks). Leks are often in grassy areas or in more open canopy sagebrush/grass habitat. Greater sage-grouse are dependent on sagebrush environments for their year-round survival, and in particular Wyoming and mountain big sagebrush, which occupy 85% of the ARPA. This dependency includes using sagebrush as forage, nesting, brood-rearing habitat, and winter thermal cover. In addition, grouse require a variety of sagebrush habitat types to meet their life history requirements. The sagebrush habitat types in the ARPA are diverse and provide a high quality environment for greater sage-grouse that is reflected in their abundance in this area. Riparian habitats are also important for brood-rearing habitat during the summer and fall months. The proximity of these two habitats to each other increases their value.

In response to petitions to list the greater sage-grouse under the ESA, the FWS conducted a status review of this species throughout its range and on January 7, 2005 determined that it did not warrant protection under the ESA. However, FWS Director Steve Williams stated that: "At the same time, the status review clearly illustrates the need for continued efforts to conserve sage-grouse and sagebrush habitats on a long-term basis." Greater sage-grouse populations in Wyoming have stabilized in recent. Because of continuing modifications of sagebrush habitats from fire, chemical and mechanical treatments, and development, the need exists to minimize such losses and to conserve and improve sage-grouse habitats through careful management practices. The greater sage-grouse is included on the Wyoming Sensitive Species List of the BLM State Director (USDI-BLM 2002a).

The State of Wyoming continues to hunt greater sage-grouse and contends that hunter harvest primarily consists of young birds which have a high mortality rate regardless of hunting. However, grouse harvest numbers have been reduced by shortening and moving back the hunting season dates and lowering the bag limits.

In order to protect greater sage-grouse breeding grounds, the BLM places a ¼-mile buffer around the edge of leks where controlled surface use (CSU) is stipulated (USDI-BLM 1990). The ¼-mile buffer around the edge of occupied or unknown status leks located on or within ¼ mile of the ARPA covers 8,124 acres or 3 % of the ARPA. Twenty of the eighty-eight leks in the ARPA are located on private and state lands which are not protected in any way from disturbance. In addition, the BLM places a two-mile lek buffer in a seasonal stipulation preventing disturbance to protect nesting and early brood-rearing habitat. Potential greater sage-grouse nesting habitat (habitat associated with 88 leks) covers 191,017 acres or 71% of the ARPA. Of this acreage, 36% is on private and state lands which are also not protected.

According to Call (1974), Braun et al. (1977), Hayden-Wing et al. (1986), and others, approximately 50% of nests are usually located within a two-mile radius of the strutting grounds. Using data collected at seven sites across Wyoming between 1994-2003, Holloran (2005) documented 45% of nests occur within a three km (approximately two-mile) buffer and 64% of the nests occurred within a five km (approximately three-mile) buffer. In addition, he also reported a correlation between nest distance from lek and success probability, suggesting increased success rates for nests > 8.5 km from a lek (61% success > 8.5 km, 44% success < 8.5 km). All research indicates that greater sage-grouse nest in suitable habitat beyond the two-mile buffer. It is likely that hens from the active leks use most of the project area for nesting and brood-rearing, which in terms of suitable habitat amounts to 92% of the ARPA. Greater sage-grouse leks and associated nesting habitats on the project area occur mostly within the big sagebrush vegetation types. Areas with medium height sagebrush and tall residual cover of bunchgrasses provide nesting habitat (Crawford et al. 2004). Suitable brood-rearing habitat consists of various height sagebrush communities and riparian areas that provide abundant forbs, insects, and succulent mesic vegetation (Crawford et al. 2004).

Winter concentration areas have not been identified and mapped yet. If any winter concentration areas are identified in the future, there would be a timing restriction applied to surface disturbing and other disruptive activities to reduce stress to wintering birds from November 15 to March 14.

Severe winter relief habitat is used during the worst of winters. Severe winter relief habitat locations were located in the ARPA, covering a total of 200 acres. Twenty-six of these acres are on private lands and are not protected. Details of the protocol used in locating and describing the severe winter relief areas and results of the study are contained in a report submitted to the BLM in 2004 (HWA 2004). This study is on-going and the results will be used to identify physical and vegetative characteristics of severe winter relief habitat patches.

Columbian Sharp-tailed Grouse. The BLM has placed the Columbian sharp-tailed grouse on the BLM Wyoming State Director's Sensitive Species List (USDI-BLM 2002a). It is one of six sub-species of sharp-tailed grouse found in North America. In Wyoming, Oedekoven (1985) documented leks on flats or slight swales of mixed shrubland habitat. Breeding and nesting habitat consisted of herbaceous vegetation types and wintering areas were found in mixed upland shrublands and wooded riparian zones along the western edge of the Sierra Madre Range. This area partially overlaps the ARPA. Habitat types associated with the distribution of

the species in the northwestern United States include sagebrush-bunch grass, meadow-steppe, mountain-shrub, and riparian zones (Giesen and Connelly 1993).

Home ranges of Columbian sharp-tailed grouse are relatively small and their activities tend to be concentrated around active leks (Oedekoven 1985). Individuals typically move up to one mile from an active lek for nesting, and up to 3.1 miles to wintering areas (Oedekoven 1985, Giesen and Connelly 1993). Columbian sharp-tailed grouse lek locations were obtained from the WGFD and six leks have been documented on or within one mile of the ARPA, which comprise 27% of the leks within the Rawlins Field Office. Potential Columbian sharp-tailed grouse nesting habitat (habitat located within one mile of a lek) covers 4,956 acres or 1.8% of the ARPA (Appendix M: Columbian sharp-tailed grouse leks nesting and brood-rearing habitat). Leks are not located on BLM lands, however 785 acres of nesting and brood-rearing habitat are. In order to protect Columbian sharp-tailed grouse breeding grounds, the BLM places a ¼-mile buffer around leks where CSU is stipulated (USDI-BLM 1990). It is likely that hens from the active leks use nesting and brood-rearing habitat within the ARPA. Wintering habitat for sharp-tailed grouse (serviceberry/mixed mountain shrub habitat) totals 287 acres, of which 278 acres are on BLM.

3.7.1.6 Raptors

As indicated in the WOS (WGFD 2003a), the WYNDD (2003), and the Atlas of Birds, Mammals, Reptiles and Amphibians in Wyoming (WGFD 1999) raptor species known to occur on and near the ARPA include: Northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), broad-winged hawk (*Buteo platypterus*), rough-legged hawk (*Buteo lagopus*), ferruginous hawk (*Buteo regalis*), golden eagle (*Aquila chrysaetos*), bald eagle (*Hiliaeetus leucocephalus*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrinus*), American kestrel (*Falco spavarius*), long-eared owl (*Asio otus*), short-eared owl (*Asio flammeus*), great-horned owl (*Bubo virginianus*), and burrowing owl (*Athene cunicularia*). The topography of the ARPA includes low bluffs and cliffs that provide suitable sites for raptor nesting. The entire project area contains suitable habitat for raptor hunting or foraging.

The total number of nest sites located on and within one mile of the ARPA is 542 (Appendix M: Raptor nest locations). Nest sites actually within the project boundary are 357. The nest sites included: burrowing owl (2), Cooper's hawk (6), ferruginous hawk (132), golden eagle (67), great horned owl (12), northern goshawk (1), American kestrel (7), long-eared owl (1), northern harrier (3), prairie falcon (23), red-tailed hawk (51), Swainson's hawk (7), sharp-shined hawk (1), and unknown raptor (44). The BLM also identified 60 additional nests that have deteriorated and are no longer present that are classified as historical. It is possible that some of the older raptor nests in the BLM records that have not been checked for many years may have also deteriorated beyond being suitable for raptor nesting.

Inactive raptor nest sites may be used in subsequent years; therefore, all nests in good condition have the potential to be active in any given year. All raptors and their nests are protected from take or disturbance under the Migratory Bird Treaty Act (16 USC, § 703 et seq.) and Wyoming Statute (WRS 23-1-101 and 23-3-108). Golden and bald eagles are also afforded additional protection under the Bald Eagle Protection Act, amended in 1973 (16 USC, §669 et seq.).

3.7.1.7 Combinations of Wildlife Concerns

The ARPA falls entirely within the Rawlins-to-Baggs Geographical Area described in the RFO draft RMP, 2004. The species richness and habitat diversity in this area is one of the greatest in the RFO. The areas within the ARPA where wildlife resource concerns overlap are illustrated on Appendix M: Overlapping Wildlife Concerns. One hundred thirteen combinations of overlapping wildlife resource concerns were identified within the ARPA. The majority (over 90%) of the ARPA contains at least one wildlife resource concern.

3.7.2 Fish

See Sections 3.8 for discussions on fish species.

3.8 SPECIAL STATUS PLANT, WILDLIFE AND FISH SPECIES

Special status species include: (1) threatened, endangered, species proposed for listing by the FWS (Under the ESA of 1973 as amended), candidate species; and (2) sensitive species identified by the BLM Wyoming State Sensitive Species List (USDI-BLM 2002a).

3.8.1 Threatened, Endangered, Proposed, or Candidate Species of Plants, Wildlife and Fish

The FWS has determined that nine species, which are listed under the ESA as threatened, endangered or proposed, or as candidate or petitioned species pursuant to the ESA, are potentially present within the RFO (USDI-FWS 2004a; Table 3-32). Additionally, ten species that are found downstream of the RFO in the Platte River and Colorado River systems may potentially be impacted if water depletions occur. More detailed information on threatened, endangered, and proposed species is presented in the Biological Assessment (BA) (Appendix G).

3.8.1.1 Plant Species

No federally listed threatened, endangered, or candidate plant species are known to occur on the ARPA. However, four listed plants that may be potentially affected by the proposed action include blowout penstemon (*Penstemon haydenii*), Ute-ladies'-tresses (*Spiranthes diluvialis*), Colorado butterfly plant (*Gaura neomexicana ssp. coloradensis*), and western prairie fringed orchid (*Platanthera praeclara*) (USDI-FWS 2004a).

Blowout penstemon: Blowout penstemon, an FWS endangered species, is known to occur in certain habitats south of the Ferris Mountains in the northern part of Carbon County. The plant has the potential to occur on the project area (Fertig 2001, USDI-FWS 2002), especially in the Sand Hills area where a few, active sand dunes are known to exist. However, the species was not found during field surveys of this area by WYNDD personnel in June 2000 (Fertig 2000).

Ute ladies'-tresses: The known locations of the species in Wyoming include Converse, Goshen, Laramie, and Niobrara Counties. This species is not known to occur within the ARPA and the likelihood of it occurring in the ARPA is low due to the following reasons: (1) much of the ARPA is very arid and there are few perennial streams, (2) the elevation of the project area is near the upper limit for the species, (3) very few moist riparian area meadows are present, (4)

Table 3-32. Threatened, Endangered, Proposed, Candidate, or Petitioned Species Potentially Present within the RFO or that May Potentially be Impacted by the Proposed Project.

Species	Scientific Name	Status
Plants		
Blowout penstemon	*Penstemon haydenii*	Endangered
Ute-ladies'-tresses	*Spiranthes diluvialis*	Threatened
Colorado butterfly plant	*Gaura neomexicana ssp. coloradensis*	Threatened
Western prairie fringed orchid*	*Platanthera praeclara*	Threatened
Mammals		
Black-footed ferret	*Mustela nigripes*	Endangered
Canada lynx	*Lynx canadensis*	Threatened
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Threatened
Birds		
Bald eagle	*Halieaeetus leucocephalus*	Threatened
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate
Whooping crane*	*Grus americana*	Endangered
Interior least tern*	*Sterna antillarum*	Endangered
Piping plover*	*Charadrius melodus*	Threatened
Eskimo curlew*	*Numenius borealis*	Endangered
Amphibians		
Wyoming toad	Bufo baxteri	Endangered
Fish		
Bonytail**	*Gila elegans*	Endangered
Colorado pikeminnow**	*Ptychocheilus lucius*	Endangered
Humpback chub**	*Gila cypha*	Endangered
Razorback sucker**	*Xyrauchen texanus*	Endangered
Pallid sturgeon*	*Scaphirhynchus albus*	Endangered

* water depletions in the Platte River system may affect these species found downstream of the ARPA.
** water depletions in the Colorado River system may affect these species found downstream of the ARPA.

the transition from stream margins to upland vegetation is abrupt, and (5) the species has only been located in eastern and southeastern Wyoming (Fertig 2002).

Colorado butterfly plant. This species is known to occur in Laramie County in southeastern Wyoming, in southwestern Nebraska and in northeastern Colorado. This species is not known and is not expected to occur on or near the ARPA.

Western prairie fringed orchid. This species is known to occur in Iowa, Kansas, Minnesota, Missouri, North Dakota, Nebraska, and Oklahoma; and in Manitoba Province, Canada (NatureServe 2003).

A small portion of the ARPA drains into the Platte River system and according to the FWS (USDI-FWS 2004a), water depletions to the Platte River system may potentially affect the western prairie fringed orchid; however, no depletions would occur as a result of this project.

3.8.1.2 Wildlife Species

Black-footed Ferret. There are no recorded sightings of black-footed ferrets within the project area (WGFD 2003a, WYNDD 2003). A total of 6,309 acres of white-tailed prairie dog colonies were identified within the ARPA (Appendix M: White-tailed prairie dog colonies). In addition, 115 acres of prairie dog towns connected to towns within the ARPA or towns located adjacent to the ARPA were identified. Aerial mapping and ground surveys indicated that the area and density of active prairie dog colonies may be sufficient to support black-footed ferrets and that the species could theoretically be present within the ARPA. Black-footed ferret surveys would be necessary prior to ground disturbing activities within prairie dog towns that meet FWS requirements for black-footed ferret surveys (Biggins et al. 1989, USDI-FWS 1989).

Between October 2000 and October 2004, nocturnal black-footed ferret surveys were conducted on prairie dog towns located in the Dry Cow Creek POD (HWA 2000a), Sun Dog POD (HWA 2000b, HWA 2001a), Blue Sky POD (HWA 2001b and HWA 2002a), and the Cow Creek Seismic Project Area (HWA 2002b) in accordance with FWS Black-Footed Survey Guidelines (USDI-FWS 1989). No black-footed ferrets or their sign were observed during the surveys.

Canada Lynx. Although Wyoming comprises part of the species' historic geographical range, no lynx sightings have been documented in the ARPA or within a six-mile buffer (WGFD 2003a). In a collaborative effort, the BLM and WYNDD completed a lynx habitat suitability map for the State of Wyoming (Beauvais et al. 2001); according to the habitat map, lands within the ARPA provide low to poor quality lynx habitat.

Preble's Meadow Jumping Mouse. In Wyoming, Preble's meadow jumping mouse is found within riparian habitat corridors east of the Laramie Range Mountains and south of the North Platte River (USDI-FWS 2004a). The ARPA is located more than 100 miles west of the known distribution of the Preble's meadow jumping mouse and this species is not expected to occur on the project area.

Bald Eagle. Although no bald eagle nests or nesting habitat occurs on the project area, nesting habitat does occur several miles south of the project and along the Little Snake River. Bald eagles have been observed on the project area primarily during December, January, and February (WGFD 2003a). The majority of bald eagle sitings within the project area are in the southern portion of the ARPA, close to the Little Snake River. Bald eagles may utilize the

project area for foraging during winter months because a large portion consists of winter range for antelope, mule deer, and elk.

Yellow-billed Cuckoo (West of the Continental Divide). Currently, the yellow-billed cuckoo west of the Continental Divide is considered a candidate species for listing under the ESA. The ARPA does not include any large riparian areas with well-developed cottonwood/riparian habitats, therefore it is unlikely that the yellow-billed cuckoo occurs in the project area and it has not been documented on the ARPA (WGFD 2003a, WYNDD 2003).

Whooping Crane. A small portion of the ARPA drains into the Platte River system and according to the FWS (USDI-FWS 2004a), water depletions in the Platte River system may contribute to the destruction or adverse modification of designated critical habitat for the whooping crane, however, no depletions would occur as a result of this project. Habitat for the whooping crane does not occur on the ARPA.

Interior Least Tern. A small portion of the ARPA drains into the Platte River system and, according to the FWS (USDI-FWS 2004a), water depletions to the Platte River system may potentially affect the interior least tern; however, no depletions would occur as a result of this project. No habitat for the interior least tern is found on the ARPA.

Piping Plover. A small portion of the ARPA drains into the Platte River system and, according to the FWS (USDI-FWS 2004a), water depletions may contribute to the destruction or adverse modification of designated critical habitat for the northern Great Plains breeding population of the piping plover; however, no depletions would occur as a result of this project. No suitable habitat for the piping plover occurs on the ARPA.

Eskimo Curlew. A small portion of the ARPA drains into the Platte River system and, according to the FWS (USDI-FWS 2004a), water depletions to the Platte River system may potentially affect the Eskimo curlew; however, no depletions would occur as a result of this project. No suitable habitat for the Eskimo curlew occurs on the ARPA.

3.8.1.3 Amphibian Species

Wyoming Toad. The Wyoming toad did not historically, and does not currently occur in or near the ARPA.

3.8.1.4 Fish Species

Four federally endangered fish species may occur as downstream residents of the Colorado River system: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USDI-FWS 2004a). The Colorado pikeminnow, bonytail, and humpback chub are all members of the minnow family. The razorback sucker is a member of the sucker family. All four of these fish species share similar habitat requirements and historically occupied the same river systems. Declines in populations of these species are mainly attributed to impacts of water development (e.g. dams and reservoirs) on natural temperature and flow regimes, creation of migration barriers, habitat fragmentation, the introduction of competitive and predatory non-native fishes, and the loss of inundated bottom lands and backwater areas (Minckley and Deacon 1991, USDI-FWS 1993). The last sighting of any of these fish species in the Little Snake River was of a single Colorado pikeminnow in 1990. Habitat for these species is not present within the ARPA, these fish species are not likely to be found in the main stem Little Snake River and its tributaries within

the ARPA, and critical habitat for these species has not been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999). However, the potential for project-related reductions in water quantity and/or quality to these tributaries to the Colorado River warrant their inclusion in this NEPA document.

One federally endangered fish species, the pallid sturgeon (*Scaphirhynchus albus*), may occur as a downstream resident of the Platte River system in Nebraska. Habitat for this species is not present within the ARPA and critical habitat for this species has not been designated in Wyoming. However, the potential for project-related reductions in water quantity and/or quality to tributaries of the Platte River warrant its inclusion in this NEPA document.

Colorado Pikeminnow. The Colorado pikeminnow is the largest member of the minnow family and occurs in swift, warm waters of Colorado Basin rivers. The species was once abundant in the main stem of the Colorado River and most of its major tributaries throughout Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and Mexico. It was known to occur historically in the Green River of Wyoming at least as far north as the City of Green River. In 1990, one adult was collected from the Little Snake River in Carbon County, Wyoming (Baxter and Stone 1995). Subsequent survey attempts to collect Colorado pikeminnow from this area of the Little Snake River by WGFD personnel failed to yield any other specimens.

Bonytail. Habitat of the bonytail is primarily limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the bonytail is thought to be the rarest of the endangered fishes in the Colorado River System.

The bonytail historically inhabited portions of the upper and lower Colorado River basins. Today, in the upper Colorado River Basin, only small, disjunct populations of bonytail are thought to exist in the Yampa River in Dinosaur National Monument, in the Green River at Desolation and Gray canyons, in the Colorado River at the Colorado/Utah border and in Cataract Canyon (Upper Colorado River Endangered Fish Recovery Program 1999).

Humpback Chub. Habitat of the humpback chub is also limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999).

The humpback chub was historically found throughout the Colorado River System, and its tributaries, which are used for spawning (Valdez et al. 2000). It is estimated that the humpback chub currently occupies 68% of its original distribution in five independent populations that are thought to be stable (Valdez et al. 2000).

Razorback Sucker. The razorback sucker is an omnivorous bottom feeder and is one of the largest fishes in the sucker family. Adult razorback sucker habitat use varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today, in the Colorado River Basin, populations of razorback suckers are only found in the upper Green River in Utah, the lower Yampa River in Colorado and occasionally in the Colorado River near Grand Junction (Upper Colorado River Endangered Fish Recovery Program 1999).

Pallid Sturgeon. The pallid sturgeon is a native fish found in the Mississippi/Missouri River system. The pallid sturgeon is present in the Platte River, a tributary to the Missouri River,

located downstream from a portion of the ARPA. According to the FWS (USDI-FWS 2004a), water depletions in the Platte River system may potentially affect the pallid sturgeon; therefore, this species is included in this document. Suitable habitat for the pallid sturgeon consists of large turbid rivers with sand or gravel bottoms. The pallid sturgeon is threatened by habitat degradation such as decreased turbidity, which can be caused by impoundments. There is no habitat for the pallid sturgeon located on the ARPA.

3.8.2 Sensitive Plant, Wildlife and Fish Species

The BLM has developed a sensitive species list for public lands in Wyoming. The objective of the designation is to ensure the overall welfare of these species is considered when undertaking actions on public land and that those actions do not contribute to the need to list the species under the provisions of the Endangered Species Act (ESA). The BLM Sensitive Species List is meant to be dynamic and would be reviewed annually with recommendations from BLM and appropriate non-BLM authorities for additions and deletions (USDI-BLM 2002a). The following species occur on the BLM Sensitive Species List in the RFO and some may occur on or near the ARPA.

3.8.2.1 Sensitive Plant Species

Eight plant species of special concern may potentially occur on or near the RFO management area (USDI-BLM 2002a). None of these species have known occurrences within the project area (WYNDD 2003). Suitable habitats for four of the eight species are absent in the ARPA and four have the potential to occur. The names, sensitivity status, probability of occurrence of these species are listed in Table 3-33: Sensitive Plant Species.

Nelson's milkvetch. This plant is a regional endemic of southwest and central Wyoming, northeast Utah, and Northwest Colorado. The known Wyoming occurrences are found in sparsely vegetated sagebrush and juniper communities. This plant has the potential to occur on the project area, however, the species has not been found within the ARPA.

Gibben's beardtongue. In Wyoming, the known occurrences of Gibben's beardtongue are confined to extreme southwest Carbon County and extreme southeast Sweetwater County near the state line. This plant has the potential to occur on the project area, however, the species has not been found within the ARPA.

Pale blue-eyed grass. In Wyoming, the plant is known from the Laramie, North Platte, and Great Divide Basins in Albany and Carbon Counties. This plant has the potential to occur on the project area, however, the species has not been found within the ARPA.

Laramie false sagebrush. The species is endemic to southeast Wyoming (Albany and Carbon Counties) but has also been reported in Converse and Natrona Counties. This species has not been found and is not expected to occur in or near the ARPA.

Laramie columbine. Laramie columbine is found within crevices of granite boulders and cliffs. This species has not been found and is not expected to occur in or near the ARPA.

Cedar Rim thistle. Cedar Rim Thistle is endemic to the Wind River and Green River basins of Central Wyoming. This plant has the potential to occur in the project area, however, the species has not been found within the ARPA.

Weber's scarlet gilia. This species has not been found and is not expected to occur in or near the ARPA.

Persistant sepal yellowcress. This species has not been found and is not expected to occur in or near the ARPA.

Table 3-33. Sensitive Plant Species with Potential to Occur On or Near the Atlantic Rim Project Area.

Common Name	Scientific Name	Status[1]	Habitat	OP[2]
Laramie columbine	*Aquilegia laramiensis*	G2/S2, FSR2	Crevices of granite boulders and cliffs 5400 to 8000'	N
Nelson's milkvetch	*Astragalus nelsonianus*	G3/S3	Alkaline clay flats, shale bluffs, pebbly slopes and volcanic cinders in sparsely vegetated sagebrush, juniper & barren clay slopes 6,500 to 8,200'	P
Cedar Rim Thistle	*Cirsium aridum*	G2Q/S2	Barren, chalky hills, gravelly slopes, and fine textured, sandy-shaley draws 6700 to 7200'	P
Weber's Scarlet Gilia	*Ipomopsis aggreggata ssp. weberi*	G5T1T2 Q/S1, FSR2	Openings in conifer forests and scrub oak woodlands 8500 to 9600'	N
Gibben's beardtongue	*Penstemon gibbensii*	G1/S1	Barren south-facing slopes on loose sandy-clay derived from Brown's Park formation; may occur in grass-dominated sites with scattered shrubs; semi-barren fringed sagebrush/thickspike wheatgrass communities with 15-20% vegetation cover, or ashy slopes amid *Cercocarpus montanus*; may also occur on outcrops of Green River Formation on steep yellowish sandstone-shale slopes below caprock edges.	P
Persistant sepal yellowcress	*Rorippia calcycina*	G3/S2S3	River banks and shorelines, usually on sandy soils near high water line	N
Pale blue-eyed grass	*Sisyrinchium pallidum*	G2G3/ S2S3	Wet meadows, stream banks, roadside ditches & irrigated meadows 7,000 to 7,900'	P
Laramie false sagebrush	*Sphaeromeria simplex*	G2/S2	Cushion plant communities on rocky limestone ridges & gentle slopes 7,500 to 8,600'	N

Sources: USDI-BLM (2002a), WYNDD (2003).
[1] **- Definition of status**
G Global rank: Rank refers to the range-wide status of a species.
T Trinomial rank: Rank refers to the range-wide status of a subspecies or variety.
S State rank: Rank refers to the status of the taxon (species or subspecies) in Wyoming. State ranks differ from state to state.
1 Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.
2 Imperiled because of rarity (often known from 6-20 occurrences) or because of factors demonstrably making a species vulnerable to extinction.
3 Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).
4 Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5 Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.
? Questions exist regarding the assigned G, T, or S rank of a taxon.
[2] **OP** - occurrence potential: **P** = potential, **N** = no potential

3.8.2.2 Sensitive Wildlife Species

Long-eared Myotis. Although this species may hibernate in Wyoming, its residency status is currently unknown and it is thought to be uncommon (WGFD 1999). Although a limited amount of sparse juniper woodland occurs on the ARPA, sightings of the species have not been documented and it is unlikely to occur there.

Fringed Myotis. The fringed myotis occupies a variety of desert, grassland, and woodland habitats throughout western North America from British Columbia to southern Mexico. The fringed myotis has been observed to the northeast, east, and west of the project area (WGFD 1999). It could potentially occur in the ARPA to feed, but hibernation is unlikely because of the lack of suitable habitat.

Spotted bat. This bat occurs sporadically across the western United States and has not been documented in the ARPA, but it may occur.

Townsend's big-eared bat. This bat can be found throughout Wyoming and its distribution is likely determined by the availability of roosts such as caves, mines, tunnels, and crevices with suitable temperatures (Clark and Stromberg 1987). The Townsend's big-eared bat has been observed to the north, east, and west of the ARPA (WGFD 1999). It may occur in the project area to feed, but is unlikely to roost there because of the lack of suitable habitat.

Pygmy rabbit. The distribution of this rabbit is across eight western states and has been documented in Sweetwater County, Wyoming. It prefers tall sagebrush and deep, soft soil for burrowing. It has the potential to occur in the ARPA.

White-tailed prairie dog. White-tailed prairie dogs occupy the grass, shrub-grass, and desert-grass habitats in the western half of Wyoming (Clark and Stromberg 1987). White-tailed prairie dogs towns were mapped on the ARPA. Collectively, a total of 6309 acres of white-tailed prairie dog colonies were identified within the ARPA; (Appendix M: White-tailed Prairie Dog Colonies). In addition, 115 acres of prairie dog towns connected or adjacent to towns within the ARPA were identified.

Black-tailed prairie dog. Black-tailed prairie dogs occupy the grass, shrub-grass, and desert-grass habitats in the northern and eastern Wyoming. This species has not been found and is not expected to occur in or near the ARPA.

Wyoming pocket gopher. The Wyoming pocket gopher is endemic to southeastern Sweetwater County and southwestern Carbon County. Populations in Carbon County are known only from Bridger's Pass but may occur elsewhere (Clark and Stromberg 1987). Based on the known distribution of the species and the availability of suitable habitat, Wyoming pocket-gophers likely occur in the ARPA.

Swift fox. The swift fox inhabits short grass and mid-grass prairies over most of the Great Plains including eastern Wyoming (Clark and Stromberg 1987). Woolley et al. (1995) studies have documented occurrences in Carbon County and Sweetwater County, however, no swift fox were found during his survey in southwestern Carbon County. Swift foxes may potentially occur on the project area.

White-faced ibis. White-faced ibis have been documented in the project area.

Trumpeter swan. In Wyoming, the trumpeter swan is an uncommon resident (WGFD 1999) and the majority occur in the Yellowstone National Park region. Trumpeter swans have been observed to the east and to the north of the ARPA (WGFD 2003a), but suitable habitat does not occur in the ARPA.

Northern goshawk. Northern goshawks are known to occur adjacent to the ARPA (WGFD 2003a).

Ferruginous hawk. The ferruginous hawk is a common species in south-central Wyoming and is known to occur and nest on the project area.

Peregrine falcon. Bird populations in and around the project area may be abundant and diverse enough to support peregrines. Peregrine falcons may at times migrate through the project area, but nesting by this species in or near the project area is unlikely due to the lack of cliffs high enough to provide suitable nesting habitat. Peregrine falcons have been observed in the ARPA (WGFD 2003a).

Greater sage-grouse. See Section 3.7.1.5.

Columbian sharp-tailed grouse. See Section 3.7.1.5.

Mountain plover. Observations of mountain plovers within and adjacent to the ARPA have been recorded by the WGFD (WGFD 2003a) and BLM wildlife biologists.

Long-billed curlew. There have been three recorded observations of this species approximately two miles northeast of the ARPA and one recorded observation in the east-central portion of the ARPA (WGFD 2003a).

Yellow-billed cuckoo (East of the Continental Divide). The last record of a yellow-billed cuckoo being detected on a Breeding Bird Survey (BBS) route in Wyoming was from 1995 (USGS Patuxent Wildlife Research Center 2004). The ARPA does not include any large riparian areas with well-developed cottonwood/riparian habitats, therefore it is unlikely that the yellow-billed cuckoo occurs in the project area and it has not been documented in the ARPA (WGFD 2003a, WYNDD 2003).

Burrowing owl. Burrowing owls are known to occur on the ARPA (WGFD 2003a).

Sage thrasher. This bird is considered a sagebrush obligate and is generally dependent on large patches and expanses of sagebrush steppe for successful breeding. Sage thrashers have been observed throughout Wyoming, including the ARPA (WGFD 2003a).

Loggerhead shrike. In Wyoming, they are a common summer resident and may be a year-round resident in the southern half of the state. Loggerhead shrikes have been observed on the ARPA (WGFD 2003a).

Brewer's sparrow. The Brewer's sparrow breeds in landscapes dominated by big sagebrush (*Artemisia tridentata*) throughout the Great Basin and intermountain West and winters in sagebrush shrublands and brush desert habitat in the southwestern United States and northern Mexico (Rotenberry et al. 1999). According to the WGFD (WGFD 2003a), Brewer's sparrow is known to occur in the ARPA.

Sage sparrow. The sage sparrow breeds in sagebrush expanses from the northern edges of the Great Basin west of the Rocky Mountains to the chapparal and sagebrush scrub in Baja California (Martin and Carlson 1998). Sage sparrows are known to occur throughout the ARPA (WGFD 2003a).

Baird's sparrow. Based on the distribution of this species and its preferred habitat, it is unlikely that it would occur in the ARPA during the breeding season, but may occur as a summer resident (WGFD 1999) or during migration (Johnsgard 1986) to wintering sites (DeGraaf et al. 1991). Two observations of Baird's sparrow were recorded by the WGFD approximately two miles northeast of the ARPA in 1981 (WGFD 2003a).

Northern leopard frog. A member of the true frog family (*Ranidae*), the northern leopard frog is an obligate of permanent water in the plains, foothills, and montane zones. Sightings of this species have been documented in all counties of Wyoming and this species has a high probability of occurring in any areas of the ARPA having perennial water (WYNDD 2003).

Great Basin spadefoot. Sightings of this species have been documented in Sweetwater, Lincoln, Fremont, and Natrona counties of Wyoming (Baxter and Stone 1992). The known distribution of the Great-basin spadefoot is west of the ARPA. No observations have been reported in the WOS (WGFD 2003a) near the ARPA. The Wyoming Species Atlas (WGFD 1999) indicates that the species' range encompasses the ARPA; however the species is unlikely to be found on the project area.

Western boreal toad. The range for boreal toads is thought to encompass the Muddy Creek watershed (Baxter and Stone 1992). However, no sightings of this species within six miles of the project area have been reported in the WOS (WGFD 2003a). It appears that habitat within the majority of the ARPA is too arid for this species to persist and thrive, but it may occur in isolated areas where habitat is suitable.

3.8.2.3 Sensitive Fish Species

Fish species that are not listed as endangered or threatened by the FWS, but may be rare or declining within the state, have been included on the BLM Wyoming Sensitive Species List (USDI-BLM 2002a). The intent of the sensitive species status is to ensure that actions on BLM-administered lands consider the welfare of these species and do not contribute to the need to list any other species under the provisions of the Endangered Species Act (USDI-BLM 2001).

Four BLM Wyoming state sensitive fish species are known to occur in portions of streams within or adjacent to the ARPA. These include the roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) (WYNDD 2003, USDI-BLM 2002a). The three warmwater fish species (roundtail chub, bluehead sucker, flannelmouth sucker) can be found within the Muddy Creek watershed downstream of the ARPA (Beatty 2005), within the ARPA, and upstream of the ARPA (WGFD 1998, 2004; Bower 2005). The Muddy Creek watershed appears to be the only stream system in Wyoming where populations of these three native, warmwater fish species exist together (WGFD 2004).

The BLM and WGFD are signatory to the *Range-wide Conservation Agreement for Roundtail Chub, Gila robusta, Bluehead Sucker, Catostomus discobolus, and Flannelmouth Sucker, Catostomus latipinnis.* This agreement establishes the BLM's commitment to implement conservation strategies developed at both the range-wide and state-wide scales for these three

species. The range-wide conservation strategy for these species identifies the enhancement and maintenance of habitat for roundtail chubs, bluehead suckers, and flannelmouth suckers as a conservation priority.

The BLM, WGFD, and the University of Wyoming have recently completed two studies to characterize the abundance, distribution, ecology, habitat requirements and genetics of the three native warmwater fish species within the Muddy Creek watershed (Beatty 2005; Bower 2005). Additional studies are underway to characterize the movement patterns of the three species within and upstream of the ARPA within the upper Muddy Creek watershed. Results obtained through 2005 have indicated that these isolated populations may represent one of the highest conservation priorities for native fishes within Wyoming (Beatty 2005; Bower 2005).

The Colorado River cutthroat trout, which is a native coldwater game fish, has been re-introduced into Muddy Creek upstream of the ARPA and Littlefield Creek, a tributary to Muddy Creek, upstream of the ARPA. Before the introduction was made, all fish in these segments of these creeks were eliminated and a fish barrier was installed on Muddy Creek, immediately upstream of McKinney Creek, to prevent non-native fish from gaining access to the stream. In addition to the Colorado River cutthroat trout, the WGFD is planning to re-introduce all native species into the segment of Muddy Creek upstream of the fish barrier. Colorado River cutthroat trout also occur upstream from the project area in the Little Snake River (Baxter and Stone 1995). This species has been petitioned for listing as threatened or endangered.

Besides Muddy Creek, the majority of other streams on the ARPA are ephemeral and, therefore, do not have the potential to support BLM Wyoming state sensitive fish species on a year-round basis. Studies indicate that the native warmwater species may ascend ephemeral tributary streams to spawn (USDI-FWS 1985, Maddux and Kepner 1988, Weiss et al. 1998). Thus, ephemeral drainages fed by runoff from the project area may provide habitat for sensitive fish on a seasonal basis.

Roundtail Chub. This species is found within the Green River drainage including portions of the Little Snake River drainage and can be found in the Muddy Creek watershed, Carbon County, Wyoming. Roundtail chubs occurring downstream (Beatty 2005), within, and upstream of the ARPA within the Muddy Creek watershed represent the most abundant population of this species known from within Wyoming (Baxter and Stone 1995, WGFD 1998, WGFD 2004b; Beatty 2005; Bower 2005). A recent status review indicated that the range of this species has been reduced roughly 55% from historical levels (Bezzerides and Bestgen 2002). Causes for observed declines in the distribution of roundtail chubs include construction of mainstream dams, altered river flows and altered water temperatures (Bezzerides and Bestgen 2002).

During the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed, roundtail chubs were most abundant in areas containing deep pools and glides with rocky substrates. Additionally, the abundance of roundtail chubs was positively associated with areas containing remnant pool habitats resulting from extensive stream drying (Bower 2005). Extensive movements of adult roundtail chubs have not been documented within the upper Muddy Creek watershed (Bobby Compton, University of Wyoming, personal communication), though movement of larvae and juveniles through drift has been documented in other portions of the Upper Colorado River Basin (Carter et al. 1986).

Bluehead Sucker. Bluehead suckers are present in the Little Snake, Green River, Snake and Bear River basins in Wyoming (Baxter and Stone 1995, WGFD 1998, WGFD 2004b). This species is found in the Muddy Creek watershed upstream, within, and downstream of the ARPA

(Baxter and Stone 1995, WGFD 1998; Beatty 2005; Bower 2005). Bezzerides and Bestgen (2002) indicate that the range of this species has declined roughly 45% from historical levels. Causes for observed declines in distribution include construction of mainstream dams, altered river flows and water temperatures, and hybridization with the white sucker (Bezzerides and Bestgen 2002). Bluehead suckers within the upper Muddy Creek watershed represent the most abundant population of this species known from within the Colorado River Basin of Wyoming (WGFD 2004b; Bower 2005).

Bluehead suckers were most abundant during the summer and fall of 2003 and 2004 in areas with rocky substrates (gravel – cobble sizes) in close proximity to pool habitats within the upper Muddy Creek watershed. These areas are most common where pool-riffle sequences are present (Bower 2005). Extensive movements of adult bluehead suckers during the spring were observed during 2005 within the upper Muddy Creek study area, presumably in association with spawning (Bobby Compton, University of Wyoming, personal communication).

Flannelmouth Sucker. This species is found primarily in the Yampa, Little Snake, Colorado, Green, and Gunnison rivers and is also common in Muddy Creek in Carbon County, Wyoming, upstream, downstream, and within the ARPA (Bower 2005). Bezzeredes and Bestgen (2002) indicate that the range of this species has declined roughly 50% from historical levels. Similar to the causes identified for the decline of other native Colorado River Basin fishes, causes for observed declines in the distribution of flannelmouth suckers include construction of mainstream dams, altered river flows and water temperatures, and hybridization with the white sucker (Bezzerides and Bestgen 2002).

Habitat features influencing the abundance of flannelmouth suckers during the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed included rocky substrates as well as deep pools and runs (Bower 2005). Movements of adult flannelmouth suckers in association with spawning have been documented within the lower Muddy Creek watershed (Beatty 2005).

Colorado River Cutthroat Trout. Colorado River cutthroat trout were the only trout native to the Green River and Little Snake River drainages in Wyoming (Baxter and Stone 1995). Historical records indicate it was present in Muddy Creek in the mid-1800s (Mark Fowden, WGFD, personal communication). Historically, this subspecies inhabited clear-water tributaries of the Colorado River in Colorado, Utah, Wyoming, and probably also in New Mexico and Arizona (Behnke 1992). This species now occupies only a fraction of its former range. Some of the most genetically "pure" of the remaining populations of this trout subspecies are found in the Little Snake River upstream of the ARPA in Carbon County, Wyoming (Baxter and Stone 1995). Colorado River cutthroat trout have been re-introduced into Littlefield Creek and Muddy Creek upstream of the ARPA. The species is generally associated with steep, clear, cold-water streams around rocky areas, riffles, deep pools, and near or under overhanging banks and logs (Binns 1977). Colorado River cutthroat trout have been extirpated from much of their original range through competition with brook trout, rainbow trout, and brown trout, and hybridization with rainbow trout (Binns 1977). Though reintroduced populations exist in close proximity upstream of the ARPA, habitats within and downstream of the ARPA are generally supportive of warmwater, not coldwater fishes. Therefore, this species is unlikely to occur within the ARPA.

3.9 RECREATION RESOURCES

3.9.1 Introduction

Hunting is the main recreation use in the ARPA. The Baggs Herd Unit of mule deer, in the southern half of the ARPA, is one of the most heavily hunted in the state. Hunters also pursue antelope and elk as well as small game and upland birds. The ARPA also attracts recreation visitors driving for pleasure and viewing wildlife. Recreational camping and off-highway vehicle (OHV) use occurs primarily as part of hunting and related activities such as scouting game. Hunting is described in Section 3.9.2.1.

Although there are no counts of recreational visits to the ARPA, overall use is believed to be low, except during and just prior to hunting season which occurs primarily in the fall (USDI-BLM 2000). Low visitation during the rest of the year is due to low population densities in proximity to the area and the historically seasonal nature of the road network. Snowdrifts in winter and rains the rest of the year have made most of the roads intermittently impassable until recent improvements in surfacing on BLM and County Roads. Visitation within the ARPA may increase in response to road improvements. The Sand Hills Area of Critical Environmental Concern (ACEC), about 8,300 acres located within the ARPA, is managed to protect vegetation and wildlife habitat and is a particularly important deer hunting area because of its unique vegetation complex. Vegetation in the area is still recovering from a fire in the early 1990s.

Visitation is also expected to increase with the stabilization and interpretation of the JO Ranch that was recently acquired in a land exchange near the Sand Hills. The Continental Divide National Scenic Trail (CDNST) is within 3 miles of the northeastern boundary of the ARPA, but it is not likely to affect visitation within the project area.

3.9.2 Recreation Resources and Use

The principal recreation resources of the ARPA are the public lands managed by the BLM. This section discusses their use primarily for hunting and secondarily for pleasure driving and wildlife viewing. There are almost no fishing resources in the ARPA, and only a few fishing opportunities near the ARPA boundaries.

The BLM is not able to measure recreation use in the GDRA, including the ARPA, so counts of non-hunting recreation are not available However, BLM personnel have observed that recreational use in the GDRA in general appears to be steady or in a slight upward trend. If favorable conditions for wildlife are sustained in the future, then hunting throughout the GDRA, and similarly within the ARPA, is likely to continue to rise slowly.

A network of many small roads and two-tracks covers the GDRA, including the ARPA, connecting more remote locations to the larger collector roads. These routes are used for recreational purposes, as well as for access to develop and maintain oil and gas wells and range improvements. The road network includes roads maintained by the BLM, counties, and private corporations. Whether improved or not, roads and two-tracks facilitate dispersed recreation and can be expected to affect the potential for dispersed recreation use in the future.

3.9.2.1 Hunting

Big game habitat is found throughout the ARPA (see Section 3.7.1.4). The ARPA attracts hunters for mule deer in particular, but also for elk, antelope, grouse, and cottontail rabbit. The

area is dry and lacks large water impoundments, so waterfowl hunting is minimal. Most big and small game hunting occurs on BLM land, with some occurring on private land by permission of the landowner or with outfitters and guides by commercial lease.

Hunting camps are often grouped near the Sand Hills, Cow Creek Butte, Lone Butte, and Five Buttes areas. Other camps are dispersed throughout the hunt areas that include the ARPA. Motels are typically fully booked during hunting season with resident as well as non-resident people who do day trips to hunt. Many other hunters in the ARPA live in Rawlins or Baggs.

Table 3-34 presents data on hunting activity that indicates the level of hunting potentially occurring in the ARPA. Hunting data are available only as totals for the designated hunt areas delineated by the Wyoming Game and Fish Department (WGFD). Data in the table are the totals for the hunt areas that include the ARPA because information is not available for smaller areas within the hunt areas (Woolley 2003). The ARPA is a significant portion of these hunt areas. The area covered by the hunt areas generally extends from I-80 south to the Wyoming-Colorado border and from Wyoming State Highway (SH) 789 east to SH 71 and the Continental Divide in the Medicine Bow National Forest. The areas include land in a variety of ownerships and a range of types and quality of huntable habitat.

Hunting seasons in the ARPA are in the early fall through winter. Mule deer, elk, antelope and sage grouse are generally hunted from September through November. Rabbits and predators are hunted in late fall and winter. Most hunting in the ARPA is of local or regional importance, with many local hunters finding it convenient and economical to hunt for sport and for game meat in the area. Hunting in the ARPA is also attractive to a national clientele that finds it appealing because they can hunt multiple big game species from a single camp on a single trip to Wyoming.

3.9.2.2 Fishing

Resources for sport fishing are limited in and near the ARPA. Upper Muddy Creek, its tributaries McKinney Creek and Littlefield Creek (both outside the ARPA), and Savery Creek (outside the ARPA) are perennial streams considered to be locally to regionally important trout fisheries. About 15 reservoirs and ponds, ranging from 0.5 to 20 acres, are present within the ARPA. Four or five of these man-made impoundments, generally designed to supply water for livestock and wildlife, are stocked annually with rainbow trout by the WGFD (1998).

Larger sport-fishing resources outside but in the vicinity of the ARPA include Rim Lake (seven miles south of Rawlins and about four miles east of the ARPA), Teton Reservoir (thirteen miles south of Rawlins and about eight miles east of the ARPA), and the Little Snake River (2 miles south of the ARPA between Baggs and Savery). Visits to these fishing resources are rarely if ever related to a recreational visit to the ARPA.

The new High Savery Dam and Reservoir Project of the Wyoming Water Development Commission (about 34 miles south of Rawlins and 10 miles east of the ARPA) is now full. The fishery in the 480-acre reservoir will be managed by the WGFD for recovery of the Colorado River cutthroat trout, and recreation facilities will include a boat ramp (Hand 2004).

Table 3-34. Indicators of Hunting Activity by Species in the WGFD Hunt Areas that Include the ARPA, 2002.

Game Species	Hunt Area(s) Involved	Total Active Hunters	Average Non-Resident Hunters	Average Hunter Success	Average Days per Hunter	Number of BLM Permitted Commercial Outfitters
Mule Deer	82 Baggs, 84 Atlantic Rim	2,784	40%	54%	4.3	13 5
Antelope	53 Baggs, 55 Red Rim, 108 Bridger Pass	453	22%	98%	3.1	9 4 3
Elk	21 Baggs, 108 South Rawlins	5,022	14%	38%	6.1	13 2
Birds & Small Game*	25 Sierra Madre	509	NA	NA	2.5	NA

* About 51 percent sage-grouse hunting and 47 percent cottontail rabbit. The remainder is dove hunting. Individual hunters may hunt more than one species. Seasons may overlap.
NA: Data not available.
Note: Waterfowl hunting is minimal in the ARPA.
Source: WGFD 2002; Blankenship Consulting LLC.

3.9.2.3 Other Recreation

Besides hunting, recreationists visit the area for pleasure driving, wildlife viewing and mountain biking. Pleasure driving occurs seasonally to view changing aspen in late September and early October. Wildlife viewing occurs primarily in the fawning season in late May and June. Raptors, sage grouse and other birds in the ARPA attract some bird watching, and "rock hounding" generates a small amount of recreational use.

Recreational camping and off-highway vehicle (OHV) use, which are popular elsewhere in the GDRA, occur in the ARPA primarily during hunting and preseason scouting visits. There are no developed campsites or open areas for off-road OHV use in the ARPA . Recreational camping usually involves the use of trailers at dispersed locations, and OHV use is permitted only on existing roads and two-tracks.

Viewing wild horses is popular in the GDRA and there is a wild horse herd in the Adobe Town Wild Horse Herd Management Area (HMA) west of SH 789, about eight miles west of the ARPA boundary. Animals in this herd are almost entirely confined to the HMA and do not attract recreational wild horse viewers to the ARPA.

3.9.3 Recreation Plans

The BLM and Carbon County have land use planning concerns, including planning for recreational land use, that may affect the recreation resources available in the ARPA. This

section reviews existing plans from these jurisdictions, focusing mainly on the BLM, which is the manager of the largest amount of land within the ARPA.

3.9.3.1 Great Divide RMP Update

The BLM is developing a new Resource Management Plan (RMP) for the Rawlins Field Office that will address the issue of recreation throughout the GDRA, which includes the ARPA. The existing Great Divide RMP, finalized in 1990, needs to be modified because of new data, changing resource conditions, changing uses of BLM lands and the increase in mineral activity.

The existing plan discusses BLM management actions to address several recreation resources in the ARPA or surrounding areas, including maintenance of developed recreation sites like Teton Reservoir, and planning for rehabilitation and mitigation of ORV use in specific problem areas within the Sand Hills area.

JO Ranch Lands

A planning effort with a potential effect on recreation in the ARPA is the expansion of the Sand Hills ACEC to include the JO Ranch Lands, approximately 1,234 acres in the Cow Creek Valley south of the existing Sand Hills ACEC. The property has been acquired through land exchange by the BLM.

The JO Ranch lands are generally unimproved grazing lands except for the ranch buildings. Recreational uses are primarily associated with pronghorn antelope, mule deer, elk, and sage grouse hunting. Other than fall hunting activity, the area attracts limited numbers of recreationists engaged in back country camping and hiking, rock hounding, wildlife observation, OHV use, outdoor photography, and scenic touring. Future management of the acquired lands will be determined through additional NEPA analyses and planning.

3.9.3.2 Carbon County Land Use Plan

According to a survey in the Carbon County Land Use Plan, fishing, hunting, overnight camping and nature appreciation are the four most important outdoor recreational activities to Carbon County residents. The plan notes that important outdoor recreational activities occur at facilities or on lands that are developed or managed by other agencies, so the plan encourages coordination to allow substantive input by the county into agency planning (Carbon County Board of Commissioners et al. 1998). The land use plan contains no specific recreation plans for land within the ARPA.

3.10 VISUAL RESOURCES

The following description of the affected environment is based on the BLM land classification program for visual resources, Visual Resource Management (VRM) (USDI-BLM 1980). Previous on-site visits, recent photographs, field notes compiled by other ID team members, conversations with BLM personnel, and interpretive work from topographic maps were used to characterize visual resources within the affected environment.

The Atlantic Rim Project Area (ARPA) is in the Rawlins-to-Baggs area managed by the BLM Rawlins Field Office. The entire geographical area is characterized by diverse upland conditions interlaced with perennial and ephemeral stream systems and riparian zones.

Diversity of topography, soils, and climate creates a range of vegetation communities in the ARPA. These communities include aspen, six types of sagebrush, juniper, mountain shrub, saline desert shrub, and riparian/wetlands. The level of plant and wildlife values within the ARPA is reflected in the special management areas, Jep Canyon ACEC and the Sand Hills ACEC, which are managed for wildlife habitat.

The Atlantic Rim itself is the most distinctive landform within the ARPA. Panoramic views are seen from the crest of the Atlantic Rim and from other high points like Wild Horse Butte and Muddy Mountain. Moving generally west from the Atlantic Rim, a combination of varied topography, buttes, and sandstone outcrops subdivides the project area into a number of smaller viewsheds. Numerous small drainages dissect the landscape and add diversity.

Some of the vegetation communities within the ARPA are large, homogeneous, continuous, and relatively undisturbed tracts. They include large blocks of continuous grass, sagebrush, and tree cover, depending on elevation, soils and water. See Section 3.5 Vegetation.

The predominant vegetation at lower elevations of the ARPA generally changes from north to south. Beginning with sagebrush and grasses in the northernmost regions near Hogback Lake, dominant vegetation changes to sagebrush, mixed desert shrub, and forbs toward the south. It then changes to a mosaic of plant communities near Dad in the middle of the project area. Continuing southward, sagebrush dominates the landscape, giving way to large grassy-looking areas of saltbush and alkaline sagebrush south of Wild Cow Creek and southeast of Wild Horse Road. At the southernmost end of the ARPA, the rugged topography is dominated by mountain shrub and sagebrush communities.

Juniper woodlands exist at higher elevations to the east and even more commonly in the mountainous areas of the southern ARPA. Vegetation colors in early spring are green and gray-green, changing to gray-green and buff-ochre as grasses and forbs cure in the summer and fall. Reddish brown of the Red Rim and buff colors of the sandstone outcrops add contrast and dominate in areas of steep topography.

Evidence of human modification in the ARPA includes improved and unimproved roads, power lines, constructed ponds, irrigated fields on private land in the southern part of the project area, and oil and gas production facilities. Existing disturbance from oil and gas development is about 604 acres. This disturbance—about 0.2% of the 270,080 total acres in the ARPA—consists of un-reclaimed area from prior development of well pads, compressor stations, and containment ponds. Overall, the scenic quality of the area as seen from State, County and BLM roads is not significantly impaired by an abundance of permanent facilities.

The ARPA's visual resources are accessible to a range of users from the existing network of public roads within the ARPA. These roads are mainly Carbon County and BLM roads, with branch roads that serve existing gas development facilities. Users of the road network include private property owners, hunters, sightseers, wildlife observers and other recreationists, as well as personnel and contractors of oil and gas development operators. Some viewsheds in the ARPA are relatively inaccessible because of the private lands that are interspersed among the public lands. This condition exists primarily in the "checkerboard" part of the ARPA in Townships 17 and 18 in Range 91 where County and BLM roads are limited or do not exist.

In varying degrees, parts of the ARPA are visible from Wyoming State Highway (SH) 71/Carbon County Road (CCR) 401, SH 789, and Interstate 80. SH 71/CCR 401 is an important access road to campgrounds in the Medicine Bow National Forest and Huston Park Wilderness.

Residents of Baggs or Dixon might have views of parts of the ARPA, depending on their location. Approximately 68 percent of the ARPA is visible from one or more of the State, County or BLM roads in or adjacent to the project area.

Management of the ARPA's visual resources falls under the BLM's VRM program. The intent of the VRM program is to preserve scenic values in concert with resource development where resource development is appropriate. BLM VRM specialists have classified the ARPA as VRM Class III (approximately 96% of the project area) and Class IV (approximately 4% of the project area) (Appendix M: Location of VRM Class III and IV Landscapes). According to the VRM rating, the level of change to visual resources allowable within these two classes of landscape is described as follows (BLM Manual 8431 - Visual Resource Contrast Rating, Appendix 2 - VRM Class Objectives):

- Class III – The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

- Class IV – The objective of this class is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Thus for projects in Class III areas, project facilities, surface disturbance and activities that contrast enough to attract viewer attention and are evident in the landscape are allowed, but they should be constructed in a manner that reflects the lines, forms, colors and textures of the characteristic landscape, so as not to dominate the landscape. Whenever possible, existing topography and vegetation should be utilized to screen project activities and facilities. In Class IV areas, activities and facilities are accepted as dominant visual features in the landscape but colors and textures should blend with the landscape and utilize existing screening possibilities.

3.11 CULTURAL AND HISTORICAL RESOURCES

3.11.1 Cultural Chronology of Area

Archaeological investigations in the Great Divide Basin and the Washakie Basin indicate the area has been inhabited by people for at least 12,000 years from Paleoindian occupation to the present. The accepted cultural chronology of the Washakie Basin is based on a model for the Wyoming Basin by Metcalf (1987) and revised by Thompson and Pastor (1995). The Wyoming Basin prehistoric chronology is documented in Table 3-35.

Paleoindian Period

The oldest period for which there is archaeological evidence is the Paleoindian, beginning ca. 12,000 years B.P. and ending around 8500 B.P. This is the transition period from the periglacial conditions of the Wisconsin ice advance during the terminal Pleistocene to the warmer and drier climatic conditions of the Holocene. A savanna-like environment with higher precipitation than

occurs today was prevalent in southwest Wyoming. Understanding paleoenvironmental conditions operating at the end of the Pleistocene and into the Holocene will provide insights into the articulation between human populations and the environment (Thompson and Pastor 1995). Paleoindian sites are rare in southwest Wyoming. However, isolated surface finds of Paleoindian projectile points are not uncommon and suggest that site preservation may be a major factor affecting the number of known sites. The Paleoindian tool assemblage includes lanceolate points, gravers, and end-scrapers.

Table 3-35. Prehistoric chronology of the Wyoming Basin.

Period	Phase	Age (B.P.)
Paleoindian		12,000 - 8500
Great Divide		8500 - 6500
Early Archaic	Opal	6500 - 4300
Pine Spring		4300 - 2800
Late Archaic	Deadman Wash	2800-2000/1800
Uinta		2000/1800 - 650
Late Prehistoric	Firehole	650 - 300/250

Source: Metcalf (1987), as modified by Thompson and Pastor (1995)
B.P. is before present

Archaic Period

Settlement and subsistence practices, in southwest Wyoming, remained largely unchanged from the end of the Paleoindian period through the Archaic and continued until at least the introduction of the horse, or even until Historic Contact. Reduced precipitation and warmer temperatures occurred ca. 8500 B.P. The environmental change at the end of the Paleoindian period led to a pattern of broad spectrum resource exploitation which is reflected in the subsistence and settlement practices of the Archaic period. The resource exploitation became more diverse. The Archaic period is divided into the Early and the Late periods and subdivided in the Great Divide and Opal and the Pine Spring and Deadman Wash phases, respectively. Large side- and corner-notched dart points and housepits are found during the Archaic period. The presence of ground stone implements suggests a greater use of plant resources during the Archaic period. Faunal assemblages from Archaic components document increased use of small animals (Thompson and Pastor 1995).

At the Yarmony site in northern Colorado, at least one housepit has been investigated which produced radiocarbon dates of ca. 6300 B.P. (Metcalf and Black 1991). The Yarmony housepit is a large, semi-subterranean, two-room dwelling containing four slab-lined storage bins, interior hearths and other floor features. Large side-notched points have not been recovered from components dated to the Great Divide phase in the Wyoming Basin. The High Point site (Murray 2001) is a multi-component residential camp occupied during the Altithermal period and one of the only Early Archaic housepit sites discovered to date within the interior basin, located west of the study area. Most other Archaic housepit sites are located along the margins of the basins or in the uplifted areas. Radiocarbon analysis of the High Point site (48CR1790) places the occupations in the Great Divide and the Opal phases of the Early Archaic period. The earliest dated context for side-notched points are Component I at Maxon Ranch (6400-6000 B.P.), west of the study area. Large side-notched points from the Great Basin and Colorado Plateau occur as early as 7000 years B.P. Radiocarbon dates have been recovered from one open camp site and a burial within the study area. Site 48CR698, a prehistoric open camp,

dates to the Deadman Wash phase of the Late Archaic period at 2190 B.P. Site 48CR4001, the Cornwell Burial site, dates to the Pine Spring phase of the Late Archaic period at 3250 B.P.

Late Prehistoric Period

The Late Prehistoric period 2000/650 B.P. is subdivided into the Uinta and the Firehole phases. Large-scale seed processing and an increase in the number of features including roasting pits is noted in the Late Prehistoric period as is the presence of pottery and the introduction of bow and arrow technology. A characteristic of the Uinta phase is clusters of semi-subterranean structures dating to ca. 1500 B.P. At least two different types of structures have been identified: a more substantial, cold weather habitation is present at the Nova site (Thompson 1989) and a less substantial, warm weather structure serving more as a windbreak, is present north of the study area, at the Buffalo Hump site (Harrell 1989). Radiocarbon dates have been recovered from two open camp sites in the study area. Site 48CR907, a prehistoric camp, dates to the Uinta phase of the Late Prehistoric period at 1520 B.P. Two dates were recovered from Site 48CR2785. Both dates are from the Uinta phase of the Late Prehistoric period, 1680 and 1880 B.P.

The Firehole phase is distinguished from the preceding Uinta phase by a dramatic decline in radiocarbon dates possibly related to a decline in population density. The South Baxter Brush Shelter site (Hoefer et al. 1992) and Firehole Basin 11 site (Metcalf and Treat 1979) are sites located west of the study area attributed to the Firehole phase.

Proto-Historic Period

The Proto-Historic period begins sometime after 300 years B.P. with the first European trade goods to reach the area, and ends with the development of the Rocky Mountain fur trade 150 years ago. The Wyoming Basin was the heart of Shoshone territory during this period, with occasional forays into the area by other groups such as the Crow and Ute (Smith 1974). The most profound influence on native cultures during this time was the introduction of the horse enabling Native Americans to expand their range. All forms of rock art denoting horses, metal implements, and other Euro-American goods are associated with the Proto-Historic period. These include the Upper Powder Spring Hunting Complex site west of the study area (Murcray 1993). Metal projectile points have been recovered from both surface and subsurface contexts in southwest Wyoming.

Historic Period

Historic use of the area is limited by the formidable topographic relief. Steep canyons, inadequate water supply, badlands, and escarpments make the area inhospitable for settlement with only limited ranching activities present. Seven historic ranches have been recorded in the study area and grazing/sheepherding activities (n=21) have also been documented. Table 3-36 represents the historic chronology of the area. Fur trapping and trading was not an important occurrence in the study area due to lack of perennial streams. The Overland Trail crosses the mid-portion of the study area trending east to west. The Cherokee Trail transects the southern portion of the study area, trending east to west. The Rawlins to Baggs Road transects the center of the study area, trending northeast to southwest.

Table 3-36. Historic chronology of the Great Divide Basin and the Washakie Basin.

Phase	Age A.D.
Proto-Historic	1720-1800
Early Historic	1800-1842
Pre-Territorial	1842-1868
Territorial	1868 – 1890
Expansion	1890 – 1920
Depression	1920 – 1939
Modern	1939 - Present

Source: Massey 1989

3.11.2 Summary of Extant Cultural Resources

The Atlantic Rim Project Area (ARPA) encompasses 422 sections of land for a total area of 270,080 acres. The Cultural Records Office in Laramie provided information on the previous work conducted and sites recorded in the project area. Records at Western Archaeological Services (WAS) were consulted. There have been 315 cultural resource projects conducted and 425 sites recorded in the project area (Prior to 2003). A Class III block inventory was completed in conjunction with preparation of the Atlantic Rim EA (Goodrick 2000). A 1600 ac survey was conducted of the Dry Cow Creek area, and two 40 ac blocks and one 10 ac block sample inventories were conducted in the Deep Creek area for a total of 90 acre, and three 40 ac blocks were sampled in the Cottonwood Creek area, for a total of 120 acres. The overall site density within the three individual blocks varied. The highest number of sites was located along drainages and near the major topographic land forms. Limited amounts of field work have resulted in the documentation of cultural resources through survey, test excavations, examination of ethnographic records, and historic record research. No excavations have been conducted in the ARPA.

In southwest Wyoming, sand deposits (sand shadows and sand sheets) are recognized as highly likely to contain cultural material. The topographic setting of the recently inventoried Dry Cow Creek block is conducive to prehistoric occupation. The block is bisected by Dry Cow Creek and the terrain is capped with Aeolian sand deposits. The topography gently slopes to the west and the south toward Dry Cow Creek which contains limited amounts of water year round. Deep Creek and Cottonwood Creek retain limited amounts of water year round with the area surrounding the creeks characterized by rugged terrain with steep slopes dissected by deep ephemeral drainages and little soil deposition. These types of settings usually do not have high site densities. It would be more likely to encounter sites along the perennial drainages. The overall site density in the study area varies with the highest number of sites located along drainages and near the major topographic land forms. Ephemeral drainages that flow into the study area from several escarpments such as Atlantic Rim, Hogback Ridge, Wild Horse Butte, Lone Butte, China Butte, Deep Creek Butte, and Cow Creek Butte as well as Doty Mountain and Muddy Mountain, flow into the major drainages such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek and Deep Creek along with their tributaries. Numerous springs are present and would be areas likely to contain cultural resources.

"There is also a potential for Native American sensitive sites or Traditional Cultural Properties (TCP) in the study area. The definition of a TCP, according to National Register Bulletin 38 (guidelines for Evaluating and Documenting Traditional Cultural Properties) is "those beliefs,

customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice." The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs and practices. Examples of properties possessing such significance include:

- A location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world;
- An urban neighborhood that is the traditional home of a particular cultural group, and that reflects its beliefs and practices;
- A location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice; and
- A location where a community has traditionally carried out economic, artistic, or other cultural practices important in maintaining its historic identity

There is also the potential for Native American rock cairns and alignments along the ridges in the study area which do not conform to the strict definition of a TCP but are considered sensitive, none-the-less.

Two projects near the study area have investigated prehistoric site distribution and site density in the Savery Creek drainages. In *Archaeological Investigations Within the Little Snake River Basin Colorado and Wyoming*, H.D. Hall (1987) "reevaluated the nature and distribution of aboriginal sites" in Savery Creek, Slater Creek, Ridge and Valley geographic zones, Juniper Ridge, and the Little Snake Valley, located immediately southeast of the current study area. The Savery Creek investigations indicate that sites are generally located in the valley bottom or lower valley terrain, on gentle inclines, near water and near major confluences.

In the *Class III Cultural Resource Inventory and Evaluation of Eleven Prehistoric Sites within the High Savery Locality at the Proposed High Savery Dam and Reservoir Alternative, Carbon County, Wyoming,*– Latham (1999) states, "The analysis domain is characterized by non-dissected to moderately dissected uplands with mostly moderate-to-steep slopes and broad-to-narrow benches and flood plains along the many streams that pass through the area". Most of the prehistoric sites within the analysis domain are situated on benches or ridges overlooking one of the main tributaries.

3.11.3 Site Types

Sites (n=425) recorded in the project area include: prehistoric sites (n=327), historic sites (n=71), and prehistoric/historic sites (n=27). The total percentage for site types is: prehistoric sites (77%), historic sites (17%), and sites with prehistoric and historic components (6%). Of the recorded cultural resources, 32% are recommended eligible (n=136) for nomination to the NRHP, 34% are recommended not eligible (n=145) for nomination to the NRHP, and 34% remain unevaluated (n=144). Table 3-37 is a summary of known cultural resources in the ARPA categorizing the sites into prehistoric open camps, prehistoric lithic debris, historic sites, and prehistoric/historic sites. Site types previously identified, recently located, or predicted to be in the ARPA are discussed below.

Table 3-37. Summary of prehistoric and historic sites located in the Atlantic Rim Project Area.

Site Eligibility					
Site Types	**No. of Sites**	**No. of Sites Eligible**	**No. of Sites Not Eligible**	**No. of Sites Unevaluated**	**% of Total Sites**
Prehistoric burial	1	1	0	0	
Habitation/hearths/FCR	230	97	55	78	
Prehistoric camp/ceramics	1	1	0	0	
Prehistoric rock shelter	1	1	0	0	
Prehistoric petroglyphs	1	1	0	0	
Prehistoric cairns	8	0	5	3	
Prehistoric stone circles	14	4	3	7	
Prehistoric camp/ground stone	2	2	0	0	
Prehistoric camp/quarry	2	2	0	0	
Total Prehistoric Camps	**260**	**109**	**63**	**88**	**61**
Lithic scatters	62	2	27	33	
Lithic scatter/ceramics	1	0	0	1	
Lithic scatter/ground stone	1	0	1	0	
Lithic scatter/quarry	3	3	0	0	
Total Lithic Debris	**67**	**5**	**28**	**34**	**16**
Historic trails	4	3	1	0	
Stage stations	6	5 - (1 listed)	0	1	
Historic inscriptions	3	2	0	1	
Historic cairns	3	0	2	1	
Historic debris/trash	25	1	21	3	
Historic ranches	7	0	1	6	
Irrigation ditches	1	0	1	0	
Ranching/herding/corrals debris	21	2	17	2	
Post Office	1	0	1	0	
Total Historic Sites	**71**	**13**	**44**	**14**	**17**
Prehistoric camp/historic debris	18	9	3	6	
Prehistoric lithic scatter/historic debris	9	0	7	2	
Total Prehistoric/Historic Sites	**27**	**9**	**10**	**8**	**6**
Total Sites	**425**	**136**	**145**	**144**	**100**

3.11.4 Prehistoric Sites

Three hundred twenty-seven prehistoric sites have been documented in the ARPA (Prior to 2003). The site types include prehistoric camps, lithic scatters, quarries, human burials, rock art, both pictographs and petroglyphs, rock alignment sites, rock shelters, stone circles, and pottery/ceramic sites

Prehistoric camps contain evidence of a broad range of activities including subsistence-related activities. Cultural remains include formal features such as fire hearths, stone rings, cairns, rock art, lithic debris, chipped stone tools, quarries, evidence of milling/vegetable processing activities including ground stone, and pottery. Single as well as long-term occupation may be represented.

Lithic scatters consist of sites containing lithic debris such as debitage or stone tools and quarries. No features or feature remnants are found at the site. The sites are interpreted as representing short-term activities.

Quarries are sites where lithic raw material was obtained and initially processed. Primary and secondary lithic procurement areas are geologic locations where chert and quartzite cobbles have been redeposited and later used by prehistoric inhabitants for tool manufacture. Three of the quarry sites in the project area are included in the lithic scatter sites and two are part of prehistoric camp sites.

Human burials, rock art, both pictographs and petroglyphs, rock alignment sites, and rock shelters have been identified as sensitive or sacred to Native Americans. Few of these types of sites have been located in all of southwestern Wyoming. One human burial is documented in the project area. The Cornwell Burial, Site 48CR4001, dates to the Pine Spring phase of the Late Archaic period at 3250 B.P. One petroglyphs site, 48CR398, is located on the west-face of a ridge overlooking Muddy Creek. One rock shelter, 48CR1755, is located on a southwest-facing ridge of an ephemeral drainage of Muddy Creek. The burial and the petroglyphs are recommended eligible for inclusion on the NRHP, while the rock shelter remains unevaluated.

Stone circle sites have been identified in the data base for the project area. The stone circle sites are generally found on ridges overlooking seasonal drainages in the project area. Prehistoric cairns are reported in the project area. The cairns are located on ridges sometimes overlooking water sources.

Pottery/ceramics are documented in the project area. Pottery is associated with the Uinta phase of the Late Prehistoric period. There are numerous pottery sites in southwestern Wyoming and northwestern Colorado. Pottery is associated with one lithic scatter and one prehistoric camp includes pottery.

Prehistoric/historic site types include prehistoric camp/historic debris scatters (n=18) and prehistoric lithic scatters/historic debris scatters (n=9). These multi-occupation sites exhibit mixed surface components.

3.11.5 Excavation Data

No sites have been extensively tested or excavated in the project area. However, several excavations have been conducted in the surrounding area contributing data about prehistory and history of the area.

3.11.6 Historic Sites

Seventy-one historic sites have been documented in the ARPA. Site types include historic trails, stage roads, stage stations, ranches, cairns, and debris. Three of the historic sites are linear trails/roads that cross portions of the project area. The Overland Trail (48CR932) crosses the middle portion of the study area, the Cherokee Trail (48SW3680/48CR3651) crosses the

southern portion of the study area, and the Rawlins to Baggs Road (48CR3648) transects the mid-portion of the study area from a north/south direction. The Overland Trail, the Cherokee Trail, and the Rawlins to Baggs Road are recommended eligible for inclusion on the NRHP. Contributing segments of the historic routes are depicted in Appendix M. Two historic roads identified by the BLM on the GLO maps include the Rawlins to JO Ranch Road and the Rawlins to Browns Hill Road. Neither road has been field inspected or recorded. Historic transportation routes (i.e. trails, roads, and railroads) command a great amount of management attention because of their overall historic importance in western settlement and expansion and their pervasive presence within the ARPA.

The Cherokee Trail (48SW3680/48CR3651) was used in the 1850s by members of the Cherokee Tribe moving from the Oklahoma Reservation to the California gold fields. A Southern Variant of the Cherokee Trail trends southwest, crossing Savory Creek staying south of Ketchum and Five Buttes. The trail then crosses the South Fork of Cherokee Creek and then Smiley Draw, remaining south of Cherokee Creek. The road continues west, keeping Wild Horse Butte to the south, descending to the Muddy Creek drainage and continuing west through Blue Gap Draw. As with any of the westward migratory trails of the mid 1800s, variants have been documented. Reasons for variations in routes include inaccessibility at certain times of year or members of the group may have traveled the route previously and found an easier or more direct avenue to water. As is the case with many historic linear properties, the route of the Cherokee Trail needs to be verified in the field. Where possible, on the ground inspection should be supplemented by diaries of early pioneers that followed the westward migration routes. Many of the diaries include pertinent information such as distances traveled, landmarks, water sources, and feed for the stock. "

"The Cherokee Trail has received a great deal of attention by writers and even the film industry. LeRoy Hafen, in his work *The Overland Mail,* contends that the pioneering efforts of the Cherokee Indians led to the eventual development of the Overland Trail. Louis L'Amour romanticized the trail in his novel *The Cherokee Trail.* And in the 1960s a television series entitled "Cherokee Trail" drew attention to this road through southern Wyoming. The net result of the combined effort of novelists, historians, and the media has been to create a highly romanticized trail that is still not well understood in terms of the people who traveled this trail and the location of the actual route of this road taken by Cherokees traveling west from Oklahoma to California in 1850" (Gardner 1999).

Excerpts from Cherokee Trail diarist found in *Cherokee Trail Diaries* (Fletcher et al. 1999) document stops along the southern variant of the Cherokee Trail. Mitchell (1850):

> "June 30 Sunday ...frosty and plenty of ice We took an object west (possibly Five Buttes) at a great distance west to travel to and had great trouble in getting to it Too many bluffs & bad branches in the way In the evening we got out of the mountains & got to a bad Swamp creek runing south (This is Muddy Creek north of Baggs, WY) Supposed to be a for of elk head (Little Snake) 7 of our men were dissatisfied with the corse we were travling & left us taking a more South corse"

While supplemental information from diaries and journals is desirable, it is not required in making the determination of whether or not a certain segment of trail or its setting is contributing or non-contributing to its eligibility.

The Overland Trail is recommended eligible for inclusion on the NRHP. According to Gardner et al. (1993) only one trail guide, published in 1859, for the Overland Trail is known to exist. Written by O. Allen, it states:

"This road is only practicable for light vehicles from Bridger's Pass to Fort Bridger, inasmuch as heavy teams cannot cross the frail bridges erected over Muddy Creek. . . . Summit of Bridger's Pass - Good grass may be found along the water courses and valleys through the section of the country. Bridger's Pass is a deep cut in the mountains, about one mile wide and 18 long, terminating in a narrow gorge or Canyon along Muddy Creek, some twelve or thirteen miles long. This Pass is always practicable, even in winter, when other passes are entirely closed. . . . .Muddy Creek - this stream furnishes abundance of speckled trout; cherries, and currents abundant in the fruit season; from this point the road continues down the valley of Muddy Creek, and crosses the creek six times to avoid rocky points at short distances along the creek. 4 miles"

Historic inscriptions have been found along the Overland Trail. Two of these sites are located three miles west of Doty Mountain and one is located three miles south of Baldy Butte. All three sites are located on the west-face of the ridge overlooking Muddy Creek.

The Rawlins to Baggs Stage Road (48CR3648) was a route used to freight goods, mail, and passengers from Rawlins to Baggs, Wyoming, and further south into northern Colorado. According to Rosenberg (1994) the route was first used in 1881 and was known as the Rawlins to White River, the Rawlins, and the Snake River Road. The route was later labeled the Baggs to Rawlins Road (1916). The road is depicted on Masi's Itinerary Map of Wyoming (1875) and Holt's Map of Wyoming (1883). The road transects the project area in a northeast to southwest direction. Stage stations were established along the route with service to ranching communities in the Little Snake River Valley. There is a strong association between the road and the history of the Ute White River Agency and the Ute Massacre. The Rawlins to Baggs Stage Road extends north of Baggs generally along the same route as Wyoming Highway 789. The Stage Road continues north and east toward Rawlins, crossing Muddy and Dry Cow creeks. Mark Miller (1997) in *Hollow Victory: The White River Expedition of 1879 and the Battle of Milk Creek,* discusses Major Thornburgh's trek from Rawlins to the White River Agency Ute Reservation in an effort to address a complaint registered by Agent N. Meeker. His route followed a segment of an old stage road. "Thornburgh's command marched from Soldier Wells to Snake River Crossing on Wednesday, September 24. Their route crossed Dry Cow Creek, then Muddy Creek again, and followed the valley south along the west bank of the stream." Historic trails rarely follow a single route across the landscape. Instead, numerous parallel or alternate routes may be evident as a result of travelers adjusting to specific conditions along the trails. Trail trace varies dramatically in its condition. The segments may be in original condition or may have been subject to disturbance by previous construction projects, other human influences (recreation or off highway travel, etc.) or natural factors including erosion. Historic trail setting is characterized as those elements of integrity of location, feeling and association that contribute to the eligibility of the trails or associated sites.

Stage stations were important to westward migration. The Washakie Stage Station (listed on the NRHP) and Sulphur Springs Stage Station, were stops along the Overland Trail. Gardner et al. (1993) states: "Construction of stage stations at Sulphur Springs, Washakie, and Duck Lake more than likely took place in 1862." This time frame coincides with Ben Holladay beginning his Overland Stage venture to connect Denver, Colorado, with Salt Lake City, Utah. "Home" stations offered travelers with more amenities than "swing" stations where a change of horses occurred and travelers meals were offered. Robert Foote, giving testimony to Senator

Cameron, during a request for reimbursement for destruction caused by Native Americans states: "Stations from Sulphur Springs west to Fort Bridger were built from stone" (Gardner et al. 1993). Along with the construction of the stage stations was the stringing of the telegraph wires. Freighters as well as emigrants used these routes. The Sulphur Springs Station was also utilized by the Rawlins to Baggs Road. Other Stage Stations documented in the AR Study Area associated with the Rawlins to Baggs Road include Muddy Creek Station, Solder Wells Station, Willow Station and 16 Mile Station.

Historic ranches recorded in the project area include the JO Ranch, the Lisco Ranch, J. Peterson Ranch, Olsen Cabin, Hay Gulch Ranch, 20 Mile Ranch, and the Pool Ranch. The JO Ranch dates to the occupation by J. Rankin in the 1890s. Rankin was a guide for the US Army in 1879. He made the 28 hour ride from the besieged troops of the Thornburg Expedition to the telegraph lines in Rawlins, Wyoming. Ranching/stock herding sites in the area are generally sheepherder camps exhibiting hole-in-top cans and purple glass. Refuse left behind from tending herds is usually located on terrain with a good view to watch over the herds as well as water. One irrigation ditch has been recorded in the ARPA. The Mesa Irrigation Ditch is located in the southern reaches of the ARPA.

Historic cairns, often associated with sheep herding, are located on ridges or high points, sometimes overlooking seasonal drainages.

Historic debris/trash sites are found distributed throughout the project area. These scatters usually include trash associated with emigration and ranching/herding activities.

3.11.7 Summary

The subsistence and settlement patterns in the project area reflect a hunter-gatherer lifeway. Research into the subsistence and settlement patterns used during the Archaic period indicates summer occupations in the mountains, winter occupations in the foothills, and spring and fall movements utilizing all available zones (Creasman and Thompson 1997). Subsistence patterns in the Archaic period and the Late Prehistoric period are similar in that they are based on seasonal movement throughout the basins and foothills in response to the availability of floral and faunal resources (Creasman and Thompson 1988). A wide diet breadth is evident in extensive procurement and processing of small mammals. By 450 B.P. (Shimkin 1986), or possibly earlier (Bettinger and Baumhoff 1982), Numic-speaking Shoshonean groups occupied the Wyoming Basin and continued to reside there until Euro-American expansion relegated them to reservations beginning in 1868.

Cultural resources are found along the major ephemeral drainages and along the lower benches of escarpments that dominate the terrain in the project area. Sensitive areas include drainages such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek and Deep Creek along with their tributaries. The numerous springs in the project area would be likely to contain cultural resources. Seasonal drainages flow into the project area from several escarpments such as Atlantic Rim, Hogback Ridge, Wild Horse Butte, Lone Butte, China Butte, Deep Creek Butte, and Cow Creek Butte as well as Doty Mountain and Muddy Mountain. Certain topographic settings have higher archaeological sensitivity such as eolian deposits (sand shadows and sand sheets), alluvial deposits along major drainages, and colluvial deposits along lower slopes of ridges. A sample inventory of the three distinct blocks indicates a higher site density in the Dry Cow Creek portion where the topographic relief gently slopes toward Dry Cow Creek (Goodrick 2000). No sites were located in the central and southern portions where terrain is steeply dissected by deep ephemeral drainages. The sampling

included ridges, drainages, and areas with limited sand deposits. Previous investigations along the Savery Creek drainages, east of the project area, support a higher site potential along streams.

Historic use of the project area was limited by terrain and lack of perennial water sources. Three known trails and six stage stations are located within the project area. Ranches, irrigation, grazing and limited ranching activities are identified by the historic debris scatters and historic record.

3.12 SOCIOECONOMICS

The primary geographic area of analysis for potential socioeconomic effects of the Proposed Action and alternatives is Carbon County, Wyoming and the communities of Baggs, Dixon and Rawlins and the community of Wamsutter in Sweetwater County, Wyoming.

This section characterizes these socioeconomic conditions in Carbon County: the economy and population, housing resources, community services, selected local and state government revenues and selected attitudes, opinions and lifestyles. Detailed information about socioeconomic conditions in the Rawlins Resource Area is available in the *Socioeconomic Profile – Rawlins* document available on the BLM's Rawlins Resource Management Plan website at http://www.rawlinsrmp.com/documents/RawlinsSocioeconomicProfile1-30-03.pdf.

3.12.1 Economic Conditions

The Carbon County economy is largely natural resource based. Basic industries, which bring revenue into the county, include oil and gas production and processing, coal mining, electric power generation, agriculture (primarily ranching and logging), some manufacturing, and transportation (primarily the Union Pacific railroad). Those portions of the retail and service sectors which serve travelers, tourists and recreation visitors are also basic. In addition, the Carbon County economic base includes state and federal government employment; for example the Wyoming State Prison at Rawlins is a major employer in the county.

Employment and earnings are two common measures of economic activity. As shown in Figure 3-4, Carbon County full and part-time employment by place of work totaled 9,666 full and part-time jobs in 2000, which was two percent less than the 1990 level and about 29 percent lower than the1980 level of 13,616 jobs (WDAI 2003a). The 1980 peak reflected a period of intensive natural resource development in the petroleum and coal and uranium mining industries. Completion of infrastructure development and a weakening of commodity prices in all of these industries ushered in a period of economic and employment decline for Carbon County and for the State of Wyoming as a whole. More recently, there was some employment volatility between 1990 and 2000: the low point of 9,344 jobs occurred in 1993 and two years later, in 1995, the high point occurred with 9,883 jobs. Between 2000 and 2002, total employment was relatively stable.

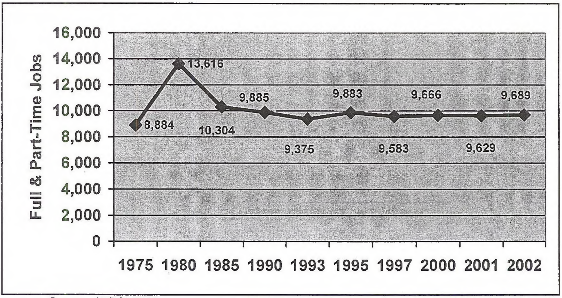
Mining sector employment, which includes direct oil and gas jobs, decreased 67 percent from 1990 to 2000, from 934 to 311 jobs and the 2000 level of mining employment was 91 percent lower than the 1980 level of 3,563 mining jobs. Mining sector jobs lost another 24 percent between 2000 and 2002. The mining sector losses over the past decade and the volatility in total employment are attributed to the shutdown of the Rosebud and Seminoe # 2 mines (USDI-BLM 1999) and more recently the closure of the RAG Shoshone mine near Hanna (Rawlins

Daily Times 2000a). Although the number of direct mining jobs in Carbon County is relatively low, mining, including the oil and gas sector, still generates a substantial number of indirect jobs in the construction, transportation and service sectors and additional induced jobs in all sectors of the economy.

Some economic sectors gained jobs between 1990 and 2000. Among the largest gainers were agricultural services and forestry, which increased from 106 to 260 jobs, a 145 percent increase, although that sector fell to 143 jobs by 2002, a 45 percent loss in just two years, reflecting the closure of the Louisiana Pacific mill in Saratoga. Other gaining sectors were construction, which increased from 595 to 693 jobs between 1990 and 2000, a 16 percent gain, and then remained relatively stable between 2000 and 2002, and services, which increased by 16 percent from, 1,848 to 2,141 jobs during the period.

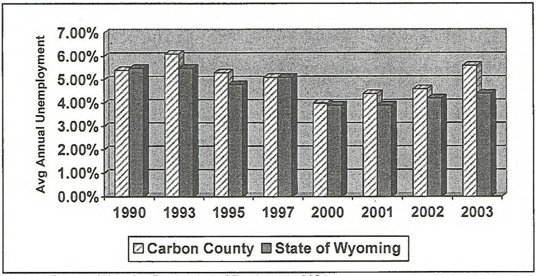
Unemployment rates in Carbon County have varied considerably in recent years, generally tracking with the unemployment rate for the state of Wyoming as a whole, although often slightly higher. Between 1990 and 2002, the county's average annual unemployment rate ranged from a low of four percent in 2000 to a high of 6.1 percent in 1993 (Figure 3-5). In 2003, the unemployment rate averaged 5.6 percent, or 451 unemployed persons in a total labor force of 8,121 (Blodgett 2003). This increase in unemployment was due in large part to the closure of the Louisiana Pacific mill. The size of the Carbon County labor force (people working or actively looking for work) decreased nine percent between 1990 and 2003 (Wyoming Department of Employment 2004).

Figure 3-4. Carbon County full and part-time employment by place of work: 1975 – 2002.



Source: WDAI 2003a

Figure 3-5. Average annual unemployment rates 1990 – 2003. Carbon County and State of Wyoming.

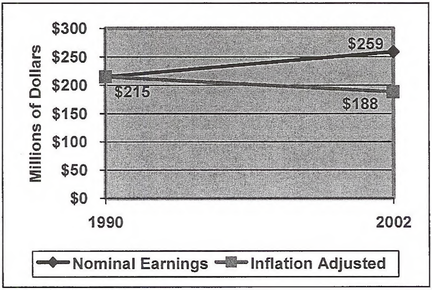


Source: Wyoming Department of Employment 2004

Although in the recent past there have been a substantial number of under-employed persons in Carbon County (PFResources 2000), there have been few experienced workers available for oil and gas drilling and completion jobs in recent years. Most drilling and completion companies bring crews with them and hire some entry-level workers locally and many gas field service companies bring workers from other states who relocate to Carbon or Sweetwater counties on a temporary, seasonal basis. However, there are qualified local contractors and employees available for gas field construction and service work (Blodget 2003, 2004).

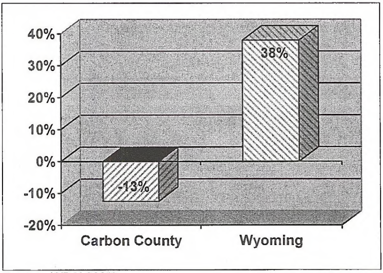
Between 1990 and 2002, total earnings associated with jobs located in Carbon County increased 20 percent, from $215 million to $259 million (Figure 3-6). However, when adjusted for inflation, real Carbon County earnings decreased by 12.5 percent during the 12 years ending in 2002. For the same period, inflation-adjusted earnings increased 38 percent for the state of Wyoming as a whole (Figure 3-7, WDAI 2003b). This general economic contraction reflects both a loss of jobs and a shift in jobs from higher paying mining jobs to generally lower paying agricultural and service jobs.

Figure 3-6. Total Carbon County earnings by place of work: 1990 – 2002.



Source: WDAI 2003b

Figure 3-7. Change in inflation-adjusted Carbon County earnings contrasted with Wyoming & US: 1990 – 2002.



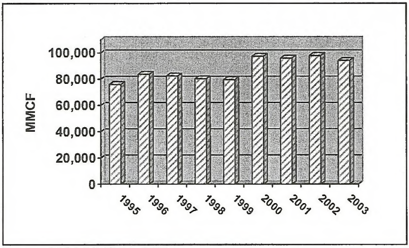
Source: WDAI 2003b

3.12.1.1 Oil and Gas Activity

As shown in Figure 3-8, Carbon County natural gas production increased, from 75,851 MMCF in 1995 to 94,183 MMCF in 2003, an increase of 24 percent, although production in 2000 through 2002 was somewhat higher than 2003 production. Carbon County oil production in 2003 was 1.6 million barrels or about 23 percent higher than the 1995 level of 1.3 million barrels, although 2002 production was about 0.1 million barrels higher. During 2003, there were a total of 1,248

producing oil and gas wells in Carbon County, and the county produced 5.14 percent of total gas produced in Wyoming and 3.05 percent of total oil.

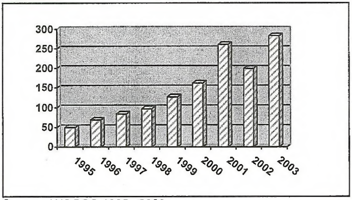
Figure 3-8. Carbon County natural gas production: 1995 – 2003.



Source: WOGCC 1995 – 2003

The outlook for future oil gas production is in part reflected in the number of approved applications for drilling permits (APD) that are logged each year. The number of approved APDs has increased substantially in Carbon County in recent years, from 50 in 1995 to 284 in 2003 and 199 in 2002 (Figure 3-9), or levels of approved drilling four or five times the level of the mid nineties (WOGCC 1995-2003). Increased drilling activity generally leads to increased production in the county if drilling efforts are successful and commodity prices remain at economic levels.

Figure 3-9. Carbon County APDs: 1995 – 2003.



Source: WOGCC 1995, 2003

3.12.1.2 Economic Activities in the Vicinity of the Proposed Action

Economic activities currently occurring on and near the ARPA include oil and gas exploration (Vosika-Neuman 2000), cattle grazing (Warren 2000) and outdoor recreation including the hunting of mule deer, antelope, elk and upland birds, and to a substantially lesser degree, off road vehicle use and camping (usually related to hunting) and pleasure driving/wildlife viewing

(see Section 3.9). Some lands within the ARPA are used by outfitters, and some ranchers lease their lands to outfitters and allow hunting for a fee (Carrico 2004).

The RFO is in the process of modifying the GDRMP, which, when modified, will be called the Rawlins Resource Management Plan (RRMP). Appendix 35 of the RRMP DEIS contains assumptions about direct expenditures, total economic activity, employment and earnings associated with grazing and recreation activities in the GDRA for the modified management plan. Tables 3-38 and 3-39 present those estimates.

Table 3-38. Economic Estimates for Grazing.

	Cattle Grazing	Sheep Grazing
Direct Expenditures Per AUM	$35.29	$21.62
Total Economic Impact Per AUM	$64.36	$42.36
Earnings Per AUM	$18.77	$5.83
Jobs Per AUM	0.000709	0.0009513

Source: Taylor 2004
All monetary values in 2000$

Table 3-39. Economic Estimates for Recreation.

	Nonresident OHV*/Day	Nonresident Hunting Day	Nonresident General Day
Direct Expenditures	$119.13	$116.31	$40.55
Total Economic Impact	$158.80	$155.97	$50.69
Total Employment	.003276	.005153	.001294
Total Earnings	$49.30	$50.80	$14.58

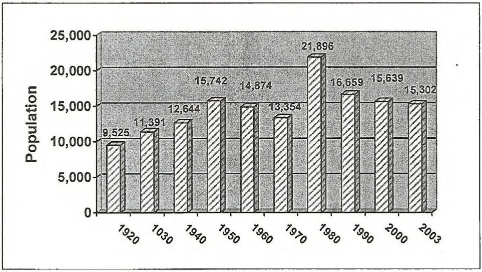
* Off-Highway Vehicle
Source: Taylor 2004
All monetary values in 2000$

3.12.2 Population

The population statistics in this section reflect census data and estimates prepared by the State pf Wyoming. In all potentially affected communities, there has been a substantial transient workforce in recent years. Because these workers do not establish permanent residence in the communities and stay in temporary housing they are not counted in population estimates. But in all affected communities, the total number of persons residing in the community at certain times of the year is substantially higher than is reflected in the following population statistics.

Carbon County's population growth and decline parallels the employment growth and decline cycle outlined at the beginning of this section. Figure 3-10 depicts the ups and downs of Carbon County's population since 1920. The population peaked in 1980 (mirroring the employment peak shown in Figure 3-4) and has decreased 29 percent since then to 15,639 in 2000, down from 21,896 in 1980 (WDAI 2001). According to official state estimates for 2003, Carbon County population continued to decline, losing another 337 people or about 2 percent since 2000 (WDAI 2002b).

Figure 3-10. Carbon County population: 1920 – 2003.



Sources: WDAI 2001 & 2003

Population in the City of Rawlins, the county seat and the largest community in Carbon County, mirrored the county trend between 1990 and 2000, although Rawlins has gained some population in the last two years as the county has continued to decline. Rawlins lost an estimated 842 persons between 1990 and 2000, ending the period at 8,538, though Rawlins officials believe the city's population was undercounted in the 2000 census (Kilgore 2002). Between 2000 and 2003, Rawlins grew slightly to an estimated 8,665 according to state estimates (see Table 3-40).

Other communities near the ARPA are small and have undergone small changes. The Town of Baggs, which, along with Dixon, is one of the closest communities to the ARPA, gained 76 residents (28 percent) between 1990 and 2000, but only gained 10 persons between 2000 and 2003, ending the period at 358 persons. The Town of Dixon, several miles east of Baggs, has been relatively stable over the last 14 years, fluctuating between 65 and 80 residents.

In Sweetwater County, the Town of Wamsutter grew by an estimated 22 persons between 1990 and 2003 according to Wyoming Department of Administration and Information estimates, although Wamsutter officials believe the number is substantially higher, both in resident population and in transient population (primarily oil and gas workers who stay in town for several weeks or months at a time) which may reach 200 or more at times (Carnes 2004).

Table 3-40. Population Estimates for Communities Near the ARPA: 1990, 1995, 2000, and 2003.

Community	1990	1995	2000*	2003
Rawlins	9,380	9,063	8,538	8,665
Baggs	272	258	348	358
Dixon	70	67	79	80
Wamsutter	240	241	261	262

Sources: 2000 Census as reported in WDAI 2003, WDAI 2001 & 2003

3.12.3 Housing Resources

As of fall of 2005, available (vacant) housing was scarce in western Carbon County and eastern Sweetwater County.

This housing inventory focuses on both long and short-term housing resources available to accommodate growth due to gas development. Operations personnel and some field development personnel would require long term housing, given the size and duration of the drilling and field development phase of the project. However, most CBNG drilling and field development activities are relatively short duration tasks performed primarily by contractors. Currently, drilling and completion activities occur less than six months out of each year, resulting in a temporary, transient workforce, and demand for temporary housing such as motel rooms and spaces for mobile homes, recreational vehicles (RVs) and rig camps near the project area.

Recently, larger self-contained worker camps have been constructed or proposed in unincorporated portions of the county, including a camp along WY 789 north of Dad that currently houses about 80 workers and can be expanded to house a total of 150 workers (Adams 2005). This site is also permitted for another camp, but is more likely that a second camp would be developed about six miles south of this area if demand arises. BP is also developing a 400 bed housing facility near Wamsutter.

Carbon County is in the process of reviewing rural subdivision regulations, which may make development of housing in unincorporated portions of the county easier. During the 2000 to 2004 period, residential building permits in Carbon County averaged about 38 per year.

3.12.3.1 Baggs/Dixon Area

In the Baggs/Dixon area, temporary housing resources include rental houses, duplexes, apartments, motels and spaces in mobile home parks. During recent years, rental units have rarely been available; most have waiting lists (Herold 2005, Hicks 2005). A 26-space mobile home park in Baggs is equipped to accommodate RVs and mobile homes. Within the park there are several mobile homes for rent, but again, these are rarely vacant. There is a four-space mobile home park in Savery and a number of mobile home lots scattered throughout the Little Snake River Valley (Grieve 2000, 2002, 2003).

There are two motels in Baggs with a total of 64 rooms, most of which can accommodate more than one occupant. Both motels routinely accommodate oil and gas industry workers as well as tourists, travelers and hunters (Willis 2000, Hawkins 2000). There is substantial turnover in these units but demand exceeds availability during the drilling and hunting seasons.

3.12.3.2 Wamsutter

Temporary housing resources in Wamsutter include three mobile home parks. One has 26 spaces (Englehart 2000, 2002), one has 70 spaces, most equipped to serve RVs (Waldner 2000, 2002), and the third is a recently reopened park with 52 spaces (Waldner 2004). Some drilling and gas service contractors have put rig camps in these mobile home parks; a rig camp typically accommodates 10 to 12 workers (two shifts of 5 or 6 workers each). There are also two motels in Wamsutter (Carnes 2003).

There has recently been a limited amount of subdivision activity and housing construction in Wamsutter (Carnes 2005). A local developer/mobile home park owner is in the process of applying for a permit to develop additional RV spaces (Waldner 2005).

3.12.3.3 Rawlins

In Rawlins, temporary housing resources include 19 motels and 4 RV parks (Hiatt 2000) and, as of fall 2005, three new motels are being constructed with a total of 200 rooms. For longer-term housing, there are 18 mobile home parks with over 550 pads (City of Rawlins 1998); about half of which were vacant during the fall of 2005. The 2000 census listed 285 units in two to four-unit housing structures in Rawlins and 467 units in structures with over 5 units (US Census Bureau 2002); there are rarely vacancies in these housing types. Although Rawlins has some vacant single-family houses, most of the affordable units are substandard, and would require some rehabilitation to make them attractive to buyers (Kilgore 2005).

3.12.4 Community Facilities and Services

3.12.4.1 Carbon County

The Carbon County Sheriff's Department provides law enforcement services for Carbon County including the ARPA. The department has 14 full-time and 2 part-time sworn deputies, including 7 who are stationed in Rawlins (Colson 2002). The department recently completed construction of a new jail.

Memorial Hospital of Carbon County would provide emergency response services in the ARPA. The hospital has 14 full and part-time emergency medical technicians (EMTs) and three ambulances based at the hospital in Rawlins (Hightree 2002).

Carbon County also provides road construction and maintenance services on roads, which provide access to and within the ARPA (see Transportation, Section 3.13).

3.12.4.2 Rawlins

Most of the infrastructure of the town of Rawlins was sized to accommodate a larger population than it currently has. The sewer system could accommodate a population of 25,000, more than twice the city's current population. With the completion of the new water supply pipeline in 2002, the water system also has excess capacity. In general, the Rawlins Community Development Director believes the community could accommodate 14,000 people with few changes to the current infrastructure (Kilgore 2002, 2004).

3.12.4.3 Baggs Area

The Carbon County Sheriff's Department provides law enforcement services in the part of Carbon County near the ARPA. Currently, coverage is provided by two full-time and one part-time deputies. The deputies provide coverage for the Town of Dixon and the community of Savery. There is one Wyoming Highway Patrol officer stationed in the area and the Town of Baggs has two police officers (Colson 2000, Herold 2004).

Medical services in Baggs are provided at a county-owned clinic, staffed by a physician's assistant who is supported by other medical and administrative personnel. Emergency response is provided by six volunteer EMTs who staff two county-owned ambulances.

Seriously injured patients are transported to Craig or Rawlins, depending on the location of the accident. Casper-based Flight-for-Life is also available if needed (Herold 2000).

Sewer and water services in the Town of Baggs would require expansion to accommodate substantial population growth. The town is limited on water supply and the water treatment plant is currently at capacity. When the recently completed High Savery reservoir is full, the Town will receive 300 acre feet per year, which would provide water supply for a population of 700. The town recently performed some improvements to its water system infiltration gallery, and is currently deciding on a design for a new treatment plant. The town's sewage treatment system has had some problems meeting discharge standards for ammonia, and may require some improvements to the aerated lagoon system. The town recently completed a utility master plan as a prelude to improving these systems. Other community facilities in Baggs are adequate for existing demand and can accommodate some population growth (Herold 2000, 2002, 2004).

3.12.4.4 Wamsutter Area

Law enforcement in the Wamsutter area is currently provided by the Sweetwater County Sheriff's Department; a deputy patrols the town daily. Two Wyoming Highway Patrol officers also live in the town. The Town of Wamsutter has positions for two part-time police officers, but the positions are currently vacant and the Town has not been able to hire officers for the positions for some time (Schroeder 2005). Emergency response services are provided by 15 volunteer EMTs operating one ambulance and 10 volunteer firefighters operating two fire trucks.

The volunteer fire and ambulance services provide coverage to surrounding oil and gas operations, and both services may have difficulty responding to more than one emergency at the same time. BP America recently provided a $68,000 grant toward purchase of a new ambulance; other energy and pipeline companies have also contributed funds. The town has an ongoing effort to recruit new volunteers for both the fire and ambulance service.

In general, sewer, water and school facilities can serve a larger population than Wamsutter now has. The town is in the second phase of a program to improve the water distribution system. The town also is developing a new library and has identified a variety of street and infrastructure improvements, vehicles and staff (Carnes 2002, 2004, Williams 2001, Rawlins Daily Times 2001). Although the transient drilling and field development population in Wamsutter can be substantial from time to time, their demands on local government facilities and services have generally been minor (Wyoming Business Council et al. 2002). Note that Wamsutter will host parts of two large pipeline construction workforces during late 2005 and 2006 (see Section 5.12) and BP America is constructing a 400 bed worker camp on the outskirts of the town in late 2005.

3.12.4.5 Carbon County School District #1

Carbon County School District (CCSD) #1 serves Rawlins, Sinclair, Baroil and the Little Snake River Valley, including the communities of Baggs and Dixon. The district's facilities were built in the late 1970s when Carbon County had many more residents, so there is excess capacity in some schools in Rawlins and Baggs. Elementary schools in Rawlins are nearing capacity; a few students could be added to each class but the addition of a substantial number of new students would require the use of modular classrooms. The Rawlins middle school could accommodate and additional 50 students and the Rawlins high school could absorb almost 1,000 students. The district plans to construct a new elementary school in Rawlins to replace the existing

elementary schools and to remodel the existing middle school. Schools in Baggs could absorb additional students, particularly if they are distributed relatively evenly across all grades.

Funding operating costs for new students can be a burden because of Wyoming's school funding formula. The Wyoming School Foundation Program provides a guaranteed level of funding to every school district in the state. If a district's local property tax revenues do not equal the guaranteed level, the State makes up the difference. If the district's revenues exceed the guaranteed level, as is the case for CCSD #1, the excess is rebated to the state for use in other districts.

The Foundation Program formula computes school district operating budgets on a three-year moving average. Therefore, if CCSD #1 has a substantial increase in enrollment in any one year, the district may not be allowed to fully increase its operating budget for the additional students for three years, unless the increase in enrollment equals or exceeds 10 percent of the district's previous year enrollment. If the district were to receive a substantial number of students in any one year, but less than a 10 percent increase over the previous year, the district would be required to hire new teachers and fund other operating increases without a corresponding increase in revenues (Blankenship 2002).

Property tax revenues accruing to District #1 may exceed the recapture limit in the near future however, which would allow the district to keep local revenue which exceeds that limit, although there are both time restrictions and spending restrictions associated with this revenue.

3.12.5 Local Government and State Government Revenues

Local and state government fiscal conditions which would be affected by development in the ARPA include ad valorem property tax revenues of Carbon County, CCSD #1 and certain special districts; sales and use tax revenues of the state, county and municipalities; state severance taxes; and federal mineral royalty distributions.

3.12.5.1 Ad Valorem Property Tax

Carbon County assessed valuation in fiscal year (FY) 2002 was about $515 million; this yielded total property tax revenues (to all taxing entities) of $32.4 million. In FY 2003, total assessed valuation had fallen to $382 million, which yielded total property tax revenues of $24.6 million. Much of this decline in property tax valuation and revenue can be attributed to lower prices for natural gas. FY 2003 assessed valuation (from FY 2002 natural gas production) totaled about $199 million, 44 percent lower than 2002 natural gas valuation. Total 2003 mill levies within the ARPA included 58.5 mills for the county, state and local schools and the weed and pest district. Special district mill levies are also assessed and would add another 3 or 4 mills, depending on the tax district. Countywide, natural gas production accounted for about 66 percent of total assessed valuation in 2002 and about 52 percent in 2003 (WTA 2002 and 2003).

3.12.5.2 Sales and Use Tax

Fiscal Year 2002 sales and use tax collections in Carbon County totaled about $18.5 million, including collections from a four percent statewide sales and use tax and a one-percent general purpose local-option sales and use tax, total FY 2003 collections fell to $14.5 million, a 22 percent reduction (WDAI 2003b). In FY 2003, Carbon County added a specific-purpose local option sales and use tax of one percent to fund construction of a new jail and other capital facilities (WDOR 2003).

3.12.5.3 Severance Taxes

Wyoming assesses severance taxes against certain minerals produced in the state. These taxes include a six percent severance tax on natural gas. In FY 2002, severance tax distributions totaled $299 million. In FY 2003, severance tax distributions climbed to $429 million, a 43 percent increase over the previous year (WDAI 2003c). Much of the increase in severance tax revenues was attributable to natural gas price increases. Of the total, 43 percent was attributable to severance taxes on natural gas in 2002 and 54 percent was attributable to natural gas in 2003.

3.12.5.4 Federal and State Mineral Royalty Distributions

The federal government collects a 12.5 percent royalty on oil and natural gas extracted from federal lands. Fifty percent of those royalties are returned to the state where the production occurred. In Wyoming, the state's share is distributed to a variety of accounts, including the University of Wyoming, the School Foundation fund, the Highway fund, the Legislative Royalty Impact Account, and to cities, towns and counties. In FY 2002, a total of $349 million in federal mineral royalty funds were distributed to Wyoming entities, in FY 2003, total mineral royalties increased to $476 million, a 36 percent increase (WDAI 2003d).

The State of Wyoming collects royalties of either 16 2/3 percent or 12 ½ percent on natural gas produced from state owned lands. The revenues generated by trust lands and minerals are dedicated to common (public) schools and certain other designated public institutions such as the Wyoming State Hospital.

3.12.6 Local Attitudes, Opinions and Lifestyles

Ranchers who own property and have grazing permits within the ARPA will be among those directly affected by the proposed natural gas development. The Little Snake River Conservation District (LSRCD) lists 13 landowners/grazing permit operators within the ARPA, nine who live in communities in the Little Snake River Valley (LSRV), three who live in Rawlins and one who lives in Saratoga. Although there are some houses and mobile homes located in the ARPA, none are occupied full-time (Carrico 2004, Hicks 2004).

Currently, cattle grazing is the primary economic activity in the ARPA, although some horses are also raised and in earlier times, the area was primarily used for sheep grazing. The more labor-intensive requirements of sheep grazing, coupled with higher labor costs, resulted in a shift towards cattle, although some sheep are still raised in the grazing allotments which include portions of the ARPA (see section 3.6.1). Some of the ranches and grazing operations located in the ARPA have been in the same family for several generations. In addition to grazing, some ranchers lease their land to hunting outfitters, or allow hunting access for a fee. Some ranches and grazing allotments have installed range improvements, including water features which benefit and attract wildlife as well as cattle.

Ranching has been the primary economic activity in the LSRV since the establishment of European settlements in the area and has been the dominate use of the land. Ranching-related activities, such as rodeos and roping competitions are among the important and long enduring social interactions in the valley (Hicks n.d.).

Resource extraction, primarily oil and more recently, natural gas, has been an important component of the economy of the LSRV. Some oil and gas service companies are located in

the valley, and natural gas development employees frequently use motels, mobile home parks and campgrounds in the LSRV while working in nearby oil and gas fields (Blevins et al. n.d., Herold 2004). A recent social assessment conducted for the Medicine Bow National Forest Plan update identified grazing permits, water rights, and to a lesser degree access to public lands as important issues for LSRV residents (Blevins et al. n.d.).

A 1996 survey conducted in conjunction with the preparation of the Carbon County Land Use Plan investigated resident attitudes and opinions regarding land use, oil and gas development, natural resource conservation and use and other topics. Just over 300 residents completed the survey (Carbon County Board of Commissioners and Carbon County Planning Commission 1998).

The most frequently listed land use issues of importance were water resource conservation and concern for government regulation of land use. These issues were followed closely by availability of water to support future land uses, economic viability of ranching, timber and oil and gas industries, and the need to conserve wildlife habitat.

County-wide, 54.9 percent of survey respondents (based on a weighted average because some respondents gave more than one response) indicated that conservation of land, water and wildlife resources was more important than increased oil and gas production, while 36.9 percent indicated that increased oil and gas production was more important.

Among Baggs residents, the reverse was true. About 54 percent rated increased oil and gas production as more important than conservation of land, water and wildlife resources while 36 percent rated resource conservation as more important. The land use plan attributes this difference in attitude to Baggs' greater economic dependence on future oil and gas employment.

Concerning management of federal lands, the largest number of respondents (69.5 percent) indicated that more federal lands within the county should be designated for the purpose of conserving fish and wildlife habitat and surface and groundwater resources. In addition, 60.8 percent of respondents indicated that more land should be designated for public recreation, 48.8 percent indicated more land should be leased for oil and gas industry exploration and production, 48.7 percent indicated more land should be leased for commercial mining, and 44.5 percent indicated more land should be made available to local timber companies for commercial timber harvest.

Coalbed natural gas development was not considered by the survey, so resident attitudes and opinions specific to CBNG are not known (Hewitt 2001).

3.12.7 Environmental Justice

Executive Order (EO) 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" was published in the *Federal Register* (59 FR 7629) on February 11, 1994. EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (defined as those living below the poverty level).

Table 3-41 presents the percentage of minorities in areas near the ARPA. Minorities are 10.3 percent of the population in the analysis area that includes the ARPA and populations within five

miles of the ARPA boundary. This is 0.8 percentage points lower than the state average of 11.1 percent. The percentage of minorities in Carbon County overall is higher than the state average because of the presence of the Wyoming State Penitentiary. Near the southern boundary of the ARPA, Baggs and Dixon have relatively low minority percentages of 7.5 percent and 5.1 percent, respectively. The Hispanic or Latino population is the largest minority group.

Table 3-42 presents the percentage of persons in poverty in ARPA and surrounding communities. For this analysis, the local area that includes the ARPA is larger than the analysis of minorities because of the data available from the U.S. Census Bureau.

Table 3-41. Percentage of Minorities in the State of Wyoming, Carbon County, the ARPA, and Selected Communities.

	Minority Persons in 2000 as % of Total Population	Percentage Points Above/Below the State Average
Wyoming	11.1	
Carbon County	17.6	6.4
ARPA and Areas Nearby [1]	10.3	-0.8
Baggs	7.5	-3.7
Dixon	5.1	-6.1

[1] Defined as Block Group 2 of Carbon County Census Tract 9676, excluding blocks generally east of the Atlantic Rim, the Bridger Pass Road, and the Little Savery Creek and Savery Creek drainages. Baggs, Dixon, and areas near Rawlins that are south of I-80 and west of Wyoming State Highway 71 are included in the analysis area.
Source: U.S. Census Bureau, Census 2000, Summary File 1

Persons in poverty are 14.1 percent of the population in the analysis area that includes the ARPA. This is higher than the overall rates for Carbon County and the state of Wyoming. However, the high poverty rate is mainly due to having to include the Wyoming State Penitentiary in the analysis area, which also includes Baggs, Dixon and other parts of Carbon County south of I-80 and west of the North Platte River.

Table 3-42. Percentage of Persons in Poverty in the State of Wyoming, Carbon County, the ARPA, and Selected Communities.

	Persons in Poverty in 1999 as % of Total Population	Percentage Points Above/Below the State Average
Wyoming	11.4	
Carbon County	12.9	1.5
ARPA and Communities Nearby[1]	14.1	2.7
Baggs	14.9	3.5
Dixon	8.0	-3.4
Rawlins	13.7	2.3
Sinclair	4.7	-6.8

[1] Defined as Block Group 2 of Carbon County Census Tract 9676, which includes Baggs, Dixon, areas near Rawlins and Sinclair south of I-80, and other parts of Carbon County south of I-80 and west of the North Platte River.
Source: U.S. Census Bureau, Census 2000, Summary File 3

3.13 TRANSPORTATION

The regional transportation system serving the project area includes an established system of interstate and state highways and county roads. County roads and improved and unimproved BLM and private roads serve local traffic on federal land. Access to the ARPA is provided by a combination of Interstate and State highways and Carbon County and BLM roads (Appendix M: Federal, State, County, and BLM Roads).

3.13.1 Highway Access to the Project Site

The Wyoming Department of Transportation (WYDOT) measures annual average daily traffic (AADT) and collects accident statistics on federal and state highways. Table 3-43 displays these data for the highways that provide access to the ARPA. WYDOT also assigns levels of service to highways in the state system. Levels of service (LOS A through LOS F) are assigned based on qualitative measures (speed, travel time, freedom to maneuver, traffic interruptions, comfort and convenience) that characterize the operational conditions within traffic streams and the perceptions of those conditions by motorists. LOS A represents the best, or free flowing, travel conditions and LOS F represents the worst, or total stoppage of traffic flows. The LOS ratings for the highways accessing the ARPA, where designated, are also shown in Table 3-43.

3.13.2 County Road Access to and within the Project Area

A number of Carbon County roads provide access to and within the ARPA. The traditional use of these county roads is to access federal, state and private lands for livestock management, recreation and more recently, oil and gas exploration and production purposes. The county has improved several county roads, including CCR 608 (Wild Cow Road) and CCR 605N (Twenty Mile Road - North), to better serve oil and gas development and production. Except for these two roads, county roads within the project area are minimally maintained and are not plowed during winter (Evans 2002).

Table 3-43. Highway Access Routes to the ARPA.

Highway	1991 AADT	2001 AADT	2002 AADT	Projected 2012 AADT	Level of Service	Average Accidents 1996–2000
I-80 (Junction WY 789)	7,590 (3,580 trucks)	12,000 (6,260 trucks)	11,760 (6,460 trucks)	15,000	A	123.4
WY 789 (Creston Jct. - Baggs)	720 (240 trucks)	890 (210 trucks)	860 (210 trucks)	800	B	18.8
WY 70 (Dixon west)	530 (65 trucks)	490 (40 trucks)	480 (30 trucks)	550		14.8
WY 71 (I-80 south)	200 (30 trucks)	150 (30 trucks)	180 (20 trucks)	160		3.2

Source: WYDOT 2000, 2001, 2002

The following provides a more detailed description of county roads providing access to and within the ARPA:

CCR 605N (Twenty Mile Road North), a 24.3-mile two-lane gravel road, provides access to federal, state and private land southwest of Rawlins. During the summer of 2001, the road was extensively improved under a cooperative effort between PEDCO and the Carbon County Road and Bridge Department. The road was re-shaped and widened, 21 culverts were installed and over 800 loads of gravel were applied. The southern end of CCR 605 N is defined by a locked gate on private land.

CCR 608 (Wild Cow Road) is a 22-mile two-lane improved and unimproved gravel and native material road which travels northeast and then southeast from the Dad intersection on WY 789, providing access to the southern part of the ARPA. CCR 608 connects with CCR 503, the McCarty Canyon Road, near the southeast border of the ARPA.

CCR 503 (McCarty Canyon Road) totals 37.2 miles in length and travels north from Dixon into the ARPA. Approximately 13 miles of CCR 503 are within the ARPA. After leaving the ARPA, the road travels north to its intersection with CCR 505, which eventually connects to WY 71 via CCR 401. The McCarty Canyon road is spot graveled and experiences moderate traffic.

CCR 501 (Cherry Grove Road) is an 8.6 mile road that provides access to the ARPA from the unincorporated community of Savery. CCR 501 runs along the southeastern border of the ARPA and intersects with CCR 752. The first 4.3 miles of CCR 501 have been improved with gravel.

CCR 752 (Stock Drive Road) connects to CCR 561N north of Savery. After it enters the eastern boundary of the ARPA, CCR 752 travels northwest for about two miles between CCR 501 and CCR 503.

3.13.3 BLM Roads within the Project Area

BLM roads providing access within the ARPA include BLM 3305, 3308 and 3309.

BLM 3305 connects with CCR 608 about five miles east of Dad, and continues northeast, providing access to the Sand Hills and the eastern side of Doty Mountain via unnamed roads and two-tracks.

BLM 3308 provides access from BLM Road 3305 to the Deep Gulch area and Cow Creek Butte areas.

BLM 3309 travels northeast from WY 789, providing access to the Wild Horse Basin area and connects to CCR 608.

3.14 HEALTH AND SAFETY

Existing health and safety concerns in and near the ARPA include hazards associated with oil and gas exploration and operations. Workers generally are exposed to the occupational hazards of oil and gas operations in the fields and at ancillary facilities. Two types of workers are employed in oil and gas fields: oil and gas workers, who had an annual accident rate of 4.0 per 100 workers in 1998, and special trades contractors, who had a non-fatal accident rate of 8.9

per 100 workers (USDL-BLS 2000). These rates compare with an overall private-industry average for all occupations of 6.2 per 100 workers.

There are also risks associated with existing natural gas pipelines, although these risks are statistically very small. Injuries associated with gas transmission pipelines nationwide averaged 14 per year from 1990 through 1996, fatalities averaged one per year and incidents such as ruptures averaged 79 per year (USDOT 1998). There are also risks associated with hazardous materials that are used and stored at oil and gas facilities; injury and incident rates are not available for these risks. The BLM, OSHA, USDOT and Wyoming OGCC each regulate safety aspects of oil and gas operations.
Existing risks within the ARPA also include those associated with vehicle travel on improved and unimproved county, BLM and oil and gas field roads; with firearms accidents during hunting season and from the casual use of firearms such as plinking and target shooting; and with natural events such as flash floods, landslides, earthquakes and range fires, which can also result from human activities

3.15 NOISE

The ARPA is located in a sparsely-populated rural setting having modest sound disturbances. The principal sound source within the ARPA is the wind. Vehicle traffic on WY 789 and WY 70, jet aircraft overflights at high altitudes, localized vehicular traffic on county, BLM and two-track roads in the Project Area, and nearby oil and gas drilling and field development activities also cause sound disturbances within the Project Area.

The EPA has established an average 24-hour noise level of 55 dBA as the maximum noise level that does not adversely affect public health and welfare. No definitive data has been established concerning noise levels that affect animals. No regulations concerning quantitative noise levels have been established by the State of Wyoming.

3.16 WILD HORSES

The RFO management area is home to approximately 1,650 wild horses, the largest population of wild, free-roaming horses (*Equis caballus*) outside of Nevada (UDSI-2003a). BLM has the responsibility to protect, manage, and control wild horses pursuant to the Wild Horse and Burro Act of 1971 (Public Law 92-195). The wild horse program is responsible for monitoring both the land and the herds, removing excess animals, and preparing animals for adoption. In Wyoming, BLM maintains and manages about 3,000 wild horses in sixteen herd management areas (HMAs). The BLM establishes an appropriate management level (AML) for each HMA. The AML is the population objective for the HMA that will ensure a thriving ecological balance among all the users and resources of the HMA.

Three wild horse HMAs are located within the RFO management area, however, none of the three are within the boundaries of the proposed ARPA. The Lost Creek and Stewart HMAs are generally located northwest of Rawlins with the larger Adobe Town HMA primarily located in southern Sweetwater County. The Stewart Creek HMA is generally located northwest of Rawlins, with its southeast boundary beginning near the intersection of U.S. Hwy. 287 and Carbon County Road 63 (about 14 miles northwest of Rawlins). The Lost Creek HMA lies within the Great Divide Basin to the west of the Stewart Creek HMA. A fenced border separates the two HMAs.

The nearest of the three HMAs to the ARPA is the Adobe Town HMA. The eastern border of the Adobe Town HMA extends to within five miles of the western boundary of the ARPA west of State Highway 789. Daily or seasonal movement of wild horses from the Adobe Town HMA to the ARPA is effectively prevented by the state-maintained, limited access fencing along Highway 789. The presence of wild horses on the project area is highly unlikely and is not considered to be an issue.

3.17 SPECIAL MANAGEMENT AREAS

Special management areas are designated to protect or preserve certain qualities or uses in areas that best provide them. The environment in these areas is unique in some regard, so that it is desirable to apply different management to the areas than is applied to the surrounding public lands. This section identifies the various special management areas (Appendix M: Special Management Areas Overview) within the ARPA and addresses the qualities or uses that have resulted in their designation. The types of special management designation within the ARPA include Areas of Critical Environmental Concern (ACECs), cultural resource management areas, cooperative fish and wildlife management areas, and other unique geographical areas.

3.17.1 Rawlins to Baggs Geographic Area

The area is bounded on the north by Interstate 80, on the east by State Highway 71 and Carbon County road 401, on the south by State Highway 70, and on the west by State Highway 789. This area contains unique and valuable vegetation and wildlife resources that require special management emphasis. The natural resources within the area draw a high number of recreationists, who enjoy the area for its wildlife, historic and cultural values, and being able to get away to secluded places. This area has a combination of diverse upland habitat conditions intertwined with perennial and ephemeral stream systems and riparian habitat combine to support a higher than normal wildlife species richness. The most important factor is the mosaic mix of these communities in close proximity to one another, based upon the diversity of topography, soils, and climate. Vegetation communities within this area include six types of sagebrush, aspen and juniper woodland, mountain shrub, saline desert shrub, and riparian/wetland communities.

South-central Wyoming is a unique area within the contiguous United States and contains vast tracts of undisturbed wildlife habitat. There is an abundance and richness of wildlife that includes big game, raptors, greater sage-grouse and Columbian sharp-tailed grouse, neotropical birds, Colorado River cutthroat trout, and native warmwater fish species such as roundtail chubs, bluehead suckers, and flannelmouth suckers. This diversity is also observed in the proximity of seasonal ranges to crucial winter ranges, the overlapping winter ranges of several big game species, and important birthing areas for antelope, mule deer, and elk. Raptor species include a wide variety of hawks, eagles and owls, as well as healthy populations of two BLM state sensitive species, ferruginous hawks and burrowing owls. This area is the only place in Wyoming where Columbian sharp-tailed grouse occur, and their range is expanding northward. There are few locations elsewhere in Wyoming that support a higher density of greater sage-grouse.

The upper Muddy Creek drainage bisects the middle of this region, and once supported Colorado River cutthroat trout in the days when Jim Bridger first explored routes for settlers that followed. These trout were recently reintroduced into the upper watershed and will soon expand

to much of their former habitat. This species, as well as native warmwater fish species, may benefit sufficiently to preclude the need to list these species for additional protection under ESA.

These plant and wildlife values are reflected in several smaller portions being proposed as SMAs including the Upper Muddy Creek Watershed/Grizzly area, Red Rim-Daley area, Jep Canyon ACEC,and the Sand Hills ACEC. However, piece-meal protection of the higher value areas would not adequately protect all the wildlife species that use and depend on this area.

This is a popular dispersed recreation destination, particularly for hunters because they can hunt multiple big game species. There is a sufficient road network to provide recreational access. The scenic quality of the area is not impaired by an abundance of permanent facilities.

Cultural values in this area include the Overland and Cherokee historic trails, the Rawlins to Baggs freight road, and the historic JO Ranch, in addition to numerous other significant cultural properties. The historic trails and roads are important reminders of settlement in this area.

3.17.2 Cow Butte/Wild Cow Area

The Cow Butte/Wild Cow area encompasses 40,414 acres of mostly public land within the ARPA. It is bounded on the north by the Sandhills ACEC and Upper Muddy Creek Watershed/Grizzly Area and on the south by the Browns Hill and Dad county roads. The area includes portions of the Cow Creek, Deep Gulch, Wild Cow and Cherokee Creek drainages. Vegetation types are diverse and intermixed, and include aspen woodland, mountain shrubs, riparian habitat, and mountain, basin and Wyoming big sagebrush. These communities provide important habitat for many wildlife species, including greater sage-grouse, Columbian sharp-tailed grouse, red-tailed and Swanson's hawks, kestrels, antelope, mule deer and elk. The western portion is elk crucial winter range where south and west slopes drop off to lower elevation plateaus. Recreation use primarily occurs during hunting seasons in the fall when this general region is one of the most heavily hunted areas in the State of Wyoming.

Existing disturbances within the ARPA portion of this SMA include improved and two-track roads, fences and water developments. Unimproved two-track roads, particularly on moderate to steep slopes, are a management concern due to the gullies and accelerated erosion associated with them. Portions of the fences in the Deep Gulch, Grizzly and Wild Cow allotments were constructed with mesh wire for control of domestic sheep that also restrict the movement of smaller, younger wildlife species, and antelope in general which like to pass under fences. Since these allotments have all been converted to cattle grazing, there is no longer a need for this type of fence since three and four wire strand barbed fence adequately controls cattle.

3.17.3 Historic Trails

Transportation routes (i.e., trails, roads, and railroads) command a great amount of management attention, due to their overall historic importance in western settlement and expansion and their presence over long distances within the Rawlins Field Office area. Some of these properties exist within the ARPA and are encountered on a frequent basis during cultural resource inventories within the area.

The Overland Trail

The Overland Trail roughly follows upper Muddy Creek through the ARPA. The trail was the principal mail and stage route west from 1862 to 1868 and its use continued thereafter as an emigrant road. Only three of the stage stations built along the trail occur on currently administered public lands including the Midway, Sage Creek, and Washakie Stations. The Washakie station, located within the ARPA along Muddy Creek, is listed on the NRHP and still retains some of the original structure. Today, evidence of the trail remains in the form of ruts and swales as well as associated artifacts.

The Rawlins to Baggs Freight Road

The Rawlins to Baggs freight road was a 19th century road connecting Rawlins and the town of Baggs to the southwest and continuing on to the White River Ute Indian Agency at Meeker, Colorado. Originally the route was used for freight but mail and passenger services were added as the region became more populated. The military used the road to transport troops and supplies from Fort Steele to Meeker during a massacre in 1879. The Rawlins to Baggs freight road parallels the 20-mile road out of Rawlins. Portions of the road are in excellent condition with deep swales and ruts present.

3.17.4 Upper Muddy Creek Watershed/Grizzly Area

The Upper Muddy Creek Watershed/Grizzly area includes 20,996 acres within the ARPA. The rugged terrain includes 9,200 acres (44%) with slopes in excess of 8%. This area contains those portions of the Muddy Creek watershed above the Weber headcut stabilization structure as well as those portions of the Savery Creek watershed within the Grizzly allotment. The Grizzly allotment is currently managed as a wildlife habitat management area in cooperation with the Wyoming Game and Fish Department. All allotments in this area have part of a Coordinated Resource Management (CRM) effort since 1992, led by the Little Snake River Conservation District, which has worked to improve grazing management and overall resource conditions. This group also mapped roads within the watershed to help define problems caused by roads, and found nearly 5,000 miles of un-improved two-tracks, or an average of about 4.6 miles/square mile for the watershed east of Hwy. 789 that includes the ARPA.

The area contains unique fish habitats that support a rare community of native Colorado River Basin fishes including Colorado River cutthroat trout, bluehead sucker, flannelmouth sucker, roundtail chub, mountain sucker, and speckled dace. The presence of this relict native fish community has resulted in the Muddy Creek watershed being listed as a top priority for aquatic habitat management by the Wyoming Game and Fish Department (WGFD 2004). Ongoing cooperative research and management efforts aim to develop and implement biologically meaningful conservation strategies for this unique fish community. This community may represent the highest conservation priority for native fishes within Wyoming (Bower 2005).

Additionally, elk crucial winter range and a corridor for elk and mule deer movement among seasonal ranges make the Muddy Creek corridor critical for big game. The high relief topography and wind deposition of snow provide a diversity of vegetation communities including aspen that provide important wildlife habitats for other species of high value such as greater sage-grouse and raptors.

Existing disturbances within this portion of the ARPA include existing improved and two-track roads, fences and water developments, and instream structures such as an irrigation diversion

and headcut stabilization structure (Bower 2005). Unimproved two-track roads, particularly on moderate to steep slopes, are a management concern due to the gullies and accelerated erosion associated with them. Portions of the fences in the Fillmore, Grizzly and Sulphur Springs allotments were constructed with mesh wire for control of domestic sheep that also restrict the movement of smaller, younger wildlife species, and antelope in general which like to pass under fences. Since these allotments have all been converted to cattle grazing, there is no longer a need for this type of fence since three and four wire strand barbed fence adequately controls cattle. Existing disturbances have led to the inclusion of two segments of Muddy Creek on the State's 303d list of impaired waterbodies. These segments were listed as impaired due to physical habitat degradation.

3.17.5 Sand Hills ACEC and Proposed JO Ranch Expansion

The Sand Hills ACEC and the JO Ranch Expansion protects about 5,024 acres of public land within the ARPA for its unique vegetation complex, wildlife habitat values, and recreational opportunities. The silver sagebrush/bitterbrush plant community, which is interspersed with patches of serviceberry, chokecherry and aspen, occurs on a deep sand soil, and is the largest representation of this vegetative mix within the State of Wyoming. This area provides crucial winter range for mule deer and elk, and nesting and foraging habitat for raptors, greater sage-grouse, and Columbian sharp-tailed grouse populations.

Recreation in this area is primarily associated with hunting activities. The high amount of vehicle use in these vegetation communities and fragile soils has resulted in a high road density (in some areas reaching nine miles of road per square mile).

The JO Ranch expansion increases the size of the current Sand Hills ACEC to 12,700 acres. The BLM acquired about 1,200 acres along Cow Creek, which includes the historic JO Ranch and the Rawlins to Baggs Freight Road. The JO Ranch is a unique example of continuous ranching activities over 100 years in the Washakie Basin. This property includes a flood irrigation system along the valley bottom which has resulted in high quality riparian habitat important for wildlife. The JO Ranch also served as a stage stop along the Rawlins to Baggs Freight Road, an historic route that connected northern Colorado with the Union Pacific Railroad line in Rawlins.

Existing disturbances within the ARPA portion of this SMA include improved and two-track roads, fences and water developments. Two-track roads are a management concern due to their high density and the disturbance and displacement of big game that occurs from vehicles. Portions of the fences in the Deep Gulch and JO Pastures allotments were constructed with mesh wire or five/six strands of barbed wire for control of domestic sheep that also restrict the movement of smaller, younger wildlife species, and antelope in general which like to pass under fences. Since these allotments have all been converted to cattle grazing, there is no longer a need for this type of fence since three and four wire strand barbed fence adequately controls cattle.

3.17.6 Red Rim/Daley Area

The Red Rim-Daley (3,190 acres within the ARPA) area is a Wyoming Game and Fish Department Cooperative Wildlife Habitat Management Area and is located approximately 15 miles southwest of Rawlins. The Red Rim area contains both the Daley Ranch allotment and the Daley Ranch Pasture. The area contains scenic values comprised of tilted red sandstone sediments and erosion features. The area provides yearlong habitat for greater sage-grouse

and crucial winter range for pronghorn, as well as important nesting substrate for a wide variety of raptors. However, the portion of the Red Rim/Daley Area overlapping into the ARPA is relatively small at 12.3% and the public land portion of the Red Rim/Daley Area within the ARPA is only about 2%. Due to this small area and location along the edge of the ARPA boundary, in addition to the values described above being protected by existing timing stipulations and BMP's on public land, there will be no further discussion of this area in this document.

CHAPTER 4

ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

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CHAPTER 4

ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.0 INTRODUCTION

The purpose of this chapter is to determine the potential for significant impact of the "federal action" on the "human environment." The Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) states that the "human environment" shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment [40 Code of Federal Regulations (CFR) §1508.14]. The "federal action" is the Bureau of Land Management's (BLM) selection of an alternative plan on which future land use actions would be based.

4.0.1 Impact Analysis

Analysis of the alternatives focuses on identifying types of impacts and estimating their potential significance. Throughout this chapter the terms "impact" and "effect" are synonymous. While impacts may be perceived as positive (beneficial) or negative (adverse), those determinations are left for the reader of this document to decide. An overview of the types of impacts is presented below. Cumulative impacts are defined and discussed separately in Chapter 5.

<u>Direct Impacts</u> - These are effects that are caused by the action and occur at the same time and place. Examples include the elimination of original land use due to the erection of a structure. Direct impacts may cause indirect impacts, such as ground disturbance resulting in resuspension of dust.

<u>Indirect Impacts</u> - These are effects that are caused by the action but occur later in time or are farther removed in distance, but are still reasonably foreseeable and related to the action by a chain of cause and effect. Indirect impacts may reach beyond the natural and physical environment (e.g., environmental impact) to include growth-inducing effects and other effects related to induced changes to resource users (e.g., non-environmental impact).

<u>Significant Impacts</u> - Both direct and indirect impacts may be significant. "Significant" requires consideration of both the context and intensity of the impact. This means that an action must be analyzed in several contexts – such as the immediate vicinity, affected interests, and the locality. Both short-term and long-term effects are relevant. Intensity refers to the severity of impact. Thus, significant impacts have intensity greater than negligible, minor, or substantial impacts (see Section 4.0.2).

BLM manages public lands for multiple uses in accordance with the Federal Land Policy and Management Act (FLPMA). Land use decisions are made that protect the resources while allowing for multiple-use of those resources, such as livestock grazing, energy development, and recreation. Where there are conflicts between resource uses, or a land use activity may result in irreversible or irretrievable impacts to the environment, BLM may restrict or prohibit some land uses in specific areas. To ensure that BLM meets its mandate of multiple-use in land management actions, the impacts of the alternatives on resource users are identified and assessed as part of the planning process. The projected impacts on land use activities and the

associated environmental impacts of land uses are characterized and evaluated for each of the alternatives.

4.0.2 Significance Criteria

Significance criteria are developed to gauge the magnitude an impact would have on the human environment. An adverse impact on resources as a result of human activities would be considered potentially significant if its magnitude was such that special mitigation is warranted or it persists indefinitely.

The concept of significance encompasses several factors, including the degree of change from existing conditions and the likelihood of the change to occur. The context and intensity of the impact are also considered. Context refers to the environmental circumstances at the location of the impact. Intensity refers to the severity or extent of an impact, including the potential for violation of laws or regulations, and the recovery or resilience of the resource.

Determining significance is complex, in that impacts are dynamic and may change during the planning period. Significance can be real and supportable by fact, or perceived and perhaps not fully supportable even with rigorous study. For this analysis, the approach to establishing significance criteria was based on legal issues (i.e., government regulatory standards), public perception, available scientific and environmental documentation, and professional judgment of resource specialists.

4.1 GEOLOGY/MINERAL RESOURCES/PALEONTOLOGY

4.1.1 Introduction

4.1.1.1 Geology (Surface Environment)/Geological Hazards

Impacts could occur to the geologic environment due to project implementation and operation as a result of removal of vegetation or soils or alteration of existing local topography—steepening slopes. Removal of vegetative or soil cover could lead to flooding as a result of decreased infiltration rates and increase overland flow rate. If unmitigated, accelerated erosion that could result may cause gullying in some areas and rapid deposition or siltation in other areas with associated negative affects. Mass movements, including landsliding could be triggered in areas that become oversteepened by erosional removal of slope supporting material. Altering existing topography, particularly by steepening slopes, could also trigger mass movements and accelerated erosion.

The proposed action or its alternatives would not contribute to increased risks of earthquakes. Earthquake-induced ground shaking could result in damage to above ground structures although the likelihood of earthquakes is low as indicated by the absence of recorded epicenters in the ARPA. Buried structures would only be affected if shaking induces ground failure or subsurface rupture. Pyrophoricity and subsidence affects to the geologic (surface) environment have been discussed in Chapter 3 and are not considered a concern.

The magnitude of impacts to the geology and geological hazards associated with the proposed action or its alternatives would be reduced by the implementation of mitigation measures for geology, soils, vegetation, and water described for described in Appendix H, Required Best Management Practices and adherence to the Great Divide RMP and draft Rawlins RMP.

4.1.1.2 Mineral Resources

Petroleum and CBNG reserves could be considerably depleted by implementation of the proposed action or alternatives within the ARPA. The proposed action and its alternatives would allow recovery of federal natural gas resources, and therefore, loss of reserves in the ground, as per 43CFR 3162.1(a), and generate private and public revenues if drilling leads to petroleum discovery and development.

No economical locatable mineral resources have been identified in the ARPA. Demand for local sand, gravel, and clinker (disposed of through the mineral materials program) for building materials for roads, well pads and other ancillary facilities, may increase. Currently permitted sources are considered adequate to meet the demand for minerals materials. Although there is the potential for mining uranium within the ARPA, no development is expected in the near future. The potential for other mineral development, including locatables (gold, other minerals) or coal is considered low.

4.1.1.3 Paleontology

Excavation of pipeline trenches and construction of well pads, access roads and ancillary facilities associated with the proposed action or its alternatives could result in the exposure and possible destruction of fossil resources of scientific significance either directly as a consequence of construction or indirectly as a result of increased erosion rate. Increased access resulting from development may increase the visibility of fossil resources and lead to increased poaching.

Conversely, excavation of pipelines and construction of project facilities could result in new fossil resources being discovered. If these newly discovered resources are properly recovered and catalogued into the collections of a museum repository, thereby making them available for study and scientific evaluation, a positive affect of the proposed action or its alternatives could occur. In addition as a positive benefit, increased access would allow easier access by professional, permitted paleontologists and geologists, who hope to make scientifically significant discoveries.

The magnitude of impacts associated with the loss of fossil resources associated with the proposed action or its alternatives would be reduced by the implementation of paleontologic resource mitigation measures described in Appendix K and 4.1.5.3.

4.1.2 Impact Significance Criteria

4.1.2.1 Geology (Surface Environment)/Geological Hazards

Impacts to geology would be significant if project implementation results in increased runoff and erosion, leading to mass movement (including landsliding), subsidence, flooding, increased erosion, or in some cases increased deposition or siltation.

4.1.2.2 Minerals

Depletion of petroleum and CBNG reserves from subsurface reservoirs resulting from the proposed action or its alternatives could be considered a significant impact.

4.1.2.3 Paleontology

Impacts to paleontological resources would be significant if scientifically important fossils are damaged or destroyed directly or indirectly as a result the proposed action or its alternatives.

4.1.3 Direct and Indirect Impacts

4.1.3.1 Proposed Action

4.1.3.1.1 Geology (Surface Environment)/Geological Hazards

Direct impacts to geology as a result of proposed action would include damage to the surface environment such as alteration of existing local topography that directly or indirectly causes increase risk of mass movements (including landslides), or results in flooding, or accelerated erosion or deposition. Indirect impacts to geology would include increased erosion that if unmitigated increases the risk of mass movements, including landslides.

4.1.3.1.2 Mineral Resources

Inventory of mineral resources in the ARPA revealed no known mineral resources that would be directly or indirectly impacted by implementation of the proposed action other than petroleum and CBNG reserves. Successful field development would result in petroleum production and depletion if permitted by federal and state agencies. Depletion, the result of production, is the purpose of this project.

Successful implementation of the Proposed Action could substantially increase petroleum and CBNG production in Carbon County, Wyoming.

Construction grade materials are likely to be used from local as yet unidentified sources for surfacing materials for petroleum and CBNG facilities. If development is extensive, accumulations of local materials may become depleted and additional sources outside of or within the ARPA would need to be identified and used.

4.1.3.1.3 Paleontology

Direct impacts to fossils would include damage or destruction of important fossils during construction, with subsequent loss of scientific information. The Proposed Action could result in direct and indirect impacts to fossil resources caused by surface disturbance, especially if disturbances affect geological formations documented in Chapter 3 within the ARPA to have a high potential to contain fossils of scientific importance (BLM Paleontology Condition 1 and 2 and Probable Fossil Yield Classes 3, 4, and 5).

However, excavation could reveal fossils of scientific significance that would otherwise have remained buried and unavailable for scientific study. If newly discovered fossils are properly collected and catalogued into the collections of a museum repository along with associated geologic data, would be available for future scientific study. In this way significant positive consequences, could result from the unanticipated discovery of previously unknown scientifically significant fossils.

4.1.3.2 Alternative A – No Action

4.1.3.2.1 Geology (Surface Environment)/Geological Hazards

No impacts to geology are anticipated under this alternative.

4.1.3.2.2 Minerals

No documented mineral resources other than oil and gas and CBNG would be affected by implementation of Alternative A.

4.1.3.2.3 Paleontology

Under the No Action Alternative, no drilling would be conducted on public lands.

4.1.3.3 Alternative B

4.1.3.3.1 Geology/Geological Hazards, Minerals, Paleontology

The number of wells drilled under this alternative is identical to the proposed action so indirect and direct impacts remain the same as the proposed action. Alternative B would restrict development to a two or three PODset where industry would drill /complete/produce/reclaim and revegetate the pods before being allowed to proceed elsewhere. Limiting disturbance to a more restricted area could have positive affect on the geology by having less surface disturbed at any one time that could be subject to erosion. Alternatively, it may result in some areas being more intensively disturbed in a smaller area, which could lead to increased erosion potential.

4.1.3.4 Alternative C

4.1.3.4.1 Geology/Geological Hazards, Minerals, Paleontology

The number of wells drilled under this alternative is identical to that under the proposed action so indirect and direct impacts remain the same as the proposed action. Alternative C would utilize a more intensive analysis and may lead to the identification of areas where multiple resources are impacted and where additional mitigation needs to be implemented. This could lessen disturbance in these areas and reduce the potential affects to geology (surface environment)/geological hazards and paleontology. However restrictions or delays in drilling and production might result, and this could have economic effects and reduce mineral extraction.

4.1.4 Impacts Summary

Implementation of the Proposed Action or alternatives B and C involve the development of surface and subsurface facilities and as a result has the potential for direct and indirect impacts to geology (surface environment), mineral, and fossil resources. The extent of ground disturbance associated with the proposed action, as well as other alternatives is described in Chapter 2. No adverse impacts to the geologic or mineral resources are anticipated under the Proposed Action or it alternatives, with the mitigation discussed in Appendix H, Required Best Management Practices. Application of this mitigation to all lands, private or public, included in the Proposed Action and its alternatives would further reduce potential direct and indirect impacts to these resources.

With the appropriate pre-disturbance surveys/inventories required in high probability occurrence areas for Paleontology (Paleontology Condition 1 and 2 areas and Probable Fossil Yield Class 3, Class 4, and Class 5 areas), and case-by-case inventories in these same areas, and as required by mitigation measures identified in Appendix H, Required Best Management Practices, the likelihood that significant fossil resources would be damaged or destroyed is reduced.

4.1.5 Additional Mitigation Measures

4.1.5.1 Geology

Mitigation measures presented in the Soils and Water resources sections would avoid or minimize the potential impacts to the surface geologic environment and lessen the possibility of mass movement, flooding, and therefore, no additional mitigation measures are required.

4.1.5.2 Minerals

No additional mitigation measures that would address petroleum depletion are proposed.

4.1.5.3 Paleontology

With implementation of mitigation measures identified in Appendix H, Required Best Management Practices for Paleontology, no additional mitigation measures are required.

4.1.6 Residual Impacts

Given the application of the mitigation measures outlined in Appendix H, Required Best Management Practices and considering that no additional mitigation measures are proposed, no residual impact discussion is required.

4.2 AIR QUALITY

Direct, indirect, and cumulative air quality impacts were analyzed to determine potential near-field ambient air pollutant concentrations, and to determine potential impacts on far-field ambient air pollutant concentrations, far-field visibility (regional haze), far-field atmospheric deposition (acid rain), and in-field (within the ARPA) concentrations.

This air quality impact assessment is based on the best available engineering data and assumptions, meteorology data, and dispersion modeling procedures, as well as professional and scientific judgment. Assumptions representing most likely operating conditions were incorporated into the analysis whenever possible. For example, for the far-field analysis, compression in the field was assumed to operate at 90% of permitted capacity. Other parameters, for which no reliable most likely operating projections were available, were assumed to occur at maximum proposed levels. For example, potential impact assessments for the Proposed Action assume that all proposed wells would be productive (no dry holes).

Air pollution potential impacts are limited by state and federal regulations, standards, and implementation plans established under the *Clean Air Act* and administered by the applicable air quality regulatory agency--specifically, the WDEQ/AQD and the EPA. Colorado, and other

regional states have similar jurisdiction over potential air pollutant emissions sources in those states, and those sources may have a cumulative potential impact when combined with WDEQ/AQD-regulated sources. The applicable air quality regulatory agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees, and control devices prior to construction and/or operation. The U.S. Congress (through the *Clean Air Act* Section 116) authorizes these local, state, and tribal air quality regulatory agencies to establish air pollution control requirements of equal or greater stringency than federal requirements. Any proposed emissions source is required to undergo a permit review by the applicable air quality regulatory agency before construction can begin. The agencies review the specific air pollutant emission sources proposed and, depending upon the magnitude of air emissions and other factors, may require additional site-specific air quality analysis and/or additional emission control measures (including a Best Available Control Technology [BACT] analysis and determination) to ensure protection of air quality.

Under FLPMA and the *Clean Air Act*, BLM cannot authorize any activity that does not conform to all applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans. An air quality impact assessment technical support document was prepared to document analyses of potential impacts from the proposed development alternatives, as well as other reasonably foreseeable emission sources within a defined cumulative analysis area. The *Atlantic Rim Natural Gas Project and the Seminoe Road Gas Development Air Quality Technical Support Document* (TRC Environmental Corporation [TRC EC] 2004) provides additional detail on this air quality evaluation and is available for review at the RFO.

4.2.1 Impact Significant Criteria

The Great Divide Resource Area RMP ROD (BLM 1990) and state (WSLUC 1979) land use plans prescribe the following management objectives associated with air quality:

- To prevent the deterioration of air quality beyond applicable local, state, or federal standards and to enhance air resources where practicable and;
- To prevent impairment of important scenic values that may be caused by declining air quality.

The significance criteria for potential air quality impacts include state and federally enforced legal requirements to ensure that air pollutant concentrations would remain within specific allowable levels, as well as adherence to the aforementioned RMP and land use plan goals and objectives. Potential impacts are considered significant if:

- Potential total near-field concentrations are greater than WAAQS or NAAQS;
- Potential total far-field concentrations are greater than applicable state ambient air quality standards or NAAQS;
- Potential cumulative near-field concentrations are greater than PSD Class II increments;
- Potential cumulative far-field concentrations in Parks and Wilderness Areas in the region are greater than PSD Class I increments;

- Potential decrease in visibility in Parks and Wilderness Areas in the regions is greater than FLAG, USFS, and /or NPS thresholds;

- Potential decrease in ANC in sensitive lakes in the region is greater than levels of acceptable change (LAC);

- Potential increases in deposition from the project are greater than deposition analysis thresholds (DAT); or

- Potential cumulative total deposition is greater than USFS levels of acceptable change.

Legal requirements include the NAAQS and WAAQS, which set maximum limits for several air pollutants, and PSD Increments, which limit the incremental increase of certain air pollutants (including NO_2, PM_{10}, and SO_2) above legally defined baseline concentration levels. These standards and increments have been presented in Table 3-6.

4.2.2 Direct and Indirect Impacts

This NEPA analysis compares potential air quality impacts from the Proposed Alternatives to applicable ambient air quality standards and PSD increments, but comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern for potential impacts, and do not represent a regulatory PSD Increment Consumption Analysis. Even though most of the development activities would occur within areas designated PSD Class II, the potential impacts on regional Class I areas are to be evaluated. For a new source review air quality permit application for a major source, the applicable air quality regulatory agencies may require a regulatory PSD increment analysis. More stringent emission controls beyond Best Available Control Technology may be stipulated in the air quality permit if potential impacts are predicted to be greater than PSD Class I or II increments.

Where legal limits have not been established, the BLM uses the best available scientific information to identify thresholds of significant potential impacts. Thresholds of levels of concern have been identified for Hazardous Air Pollution (HAP) exposure, incremental cancer risks, a "just noticeable change" in potential visibility impacts, and potential atmospheric deposition impacts to sensitive lake water chemistry. These thresholds or levels of concern are described later in this chapter.

Air quality potential impacts from the Project would occur from pollutants emitted during construction (due to potential surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well completion and testing, and drilling rig and vehicle engine exhaust) and production (natural gas well-site production equipment, reciprocating pipeline compression engine exhausts, vehicle traffic engine exhausts, and fugitive dust). Pollutants emitted from these activities include PM_{10}, $PM_{2.5}$, NO_x, CO, SO_2, VOC, and HAPs (benzene, toluene, ethylbenzene, xylene, n-hexane, and formaldehyde). O_3 may also develop from NO_x and VOC emissions. The amount of air pollutant emissions during construction and production may be controlled in part by BACT requirements implemented by WDEQ-AQD and using mitigation methods outlined in this document. Actual air quality potential impacts from these air pollutants would depend on the amount, duration, location, and emission characteristics of potential emissions sources, as well as meteorological conditions (wind speed and direction, precipitation, relative humidity, etc.).

The assessment of direct Project potential impacts included a near-field analysis and a far-field analysis. The near-field analysis assessed direct project potential impacts in the immediate vicinity of Project activities resulting from a single phase of construction or production reflective of maximum emissions. The far-field analysis assessed direct Project potential impacts from field-wide Project emissions at in-field locations within the ARPA and at far-field locations (i.e., sensitive Class I and Class II areas). The far-field analysis also assessed regional emission sources located within the model domain illustrated in Appendix M: PSD Class I and Class III Sensitive Areas and Sensitive Lakes to predict cumulative potential impacts at in-field and far-field locations. While there may be additional gas processing and/or transmission requirements due to the development of this and other natural gas projects regionally and nationally, the potential effects of these developments are not quantified herein since these developments are speculative and would likely require additional WDEQ/AQD permitting if they eventually are proposed. The near-field and far-field potential impact analyses were completed for the Proposed Action and No Action Alternative.

Near-Field Analysis

The near-field analysis analyzed direct Project potential impacts within the ARPA and utilized air pollutant emission rates which were calculated for all phases of construction and production based on WDEQ/AQD guidance. The AERMOD model was used to assess modeled impacts from the phase of either: 1) single-well construction, or 2) field production that produced the highest emissions. The near-field analysis for PM_{10}, $PM_{2.5}$, and SO_2 focused on localized modeled impacts from construction and drilling activities at a single well pad. The near-field analysis for NO_x, CO, and HAPs modeled 2,000 developed wells, to reflect the maximum number of wells in production, of which 10 percent were considered conventional natural gas wells and the remaining 90% CBNG wells. NO_x, CO, and formaldehyde modeling included emissions from 12 compressor stations to be located within the project area: Blue Sky, Brown Cow, Cow Creek, Doty Mountain, Jolly Roger, Muddy Mountain, Red Rim, Sun Dog, and four additional planned stations.

A near-field analysis of O_3 potential impacts was conducted separately. O_3 is formed through the chemical reaction of NO_x and VOCs within the atmosphere in the presence of sunlight. A nomograph developed from the Reactive Plume Model (RPM) (Scheffe 1988) was used to estimate the maximum ozone potential impacts based on NO_x and VOC emissions generated from the Project. Emissions from a representative localized production area consisting of 17 conventional natural gas wells and the Jolly Roger compressor station were used in this analysis.

Acute (short-term) HAP potential impacts were modeled by assuming that a person would not persistently remain at a location closer than 100 m (328 ft) from a well pad or a compressor station due to site operations safety considerations. Long-term (chronic) health-based HAP potential impacts and long-term (chronic) cancer risk were modeled using the realistic estimate of long-term exposure, which assumed that a person would not be closer than the nearest residence just west of the ARPA, located 5.5 miles from a well pad or compressor site, when averaged over a lifetime. Two estimates of cancer risk were made: 1) one that corresponds to a most-likely-exposure (MLE) over a national residency average of 9 years with some time spent away from home, and 2) one reflective of the maximally-exposed-individual (MEI) residing at one location for a lifetime with no time spent away from home. The estimated cancer risks were calculated based on EPA (1997) unit risk factors for carcinogenic constituents

Far-Field Analysis

The far-field analysis utilized the EPA CALMET/CALPUFF modeling system to predict maximum air quality impacts at mandatory federal PSD Class I and other sensitive PSD Class II areas, as well as designated acid-sensitive lakes within these areas. The analysis also included a potential air quality impact assessment at in-field locations within the ARPA to determine maximum concentrations that could occur from all sources operating simultaneously in the field.

The air emissions modeled for Project and non-Project sources in the far-field analysis are presented in Table 4-1. The modeling scenario developed for the Proposed Action assumed the maximum field emissions that could potentially occur concurrently: during the final year of construction representing the maximum annual construction activity rate combined with nearly full-field production. Maximum emissions scenarios include production emissions (producing wellsites and ancillary equipment including compressor stations) and construction emissions (drilling rigs and associated traffic), both occurring continuously over the year. Compressor stations were modeled at currently known or anticipated locations within the ARPA, and wellsites and construction activities were modeled evenly throughout the entire ARPA. Details on modeling methodology are presented in the Air Quality Technical Support Document (TRC EC 2004).

Table 4-1. Project and Non-Project Emissions (tons/yr) Included in Far-Field Analysis, Atlantic Rim Natural Gas Drilling Project, Carbon County, Wyoming, 2004.[1]

Source Category	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Project Sources				
Proposed Action	1,278.5	58.2	780.4	170.6
No Action	0.0	0.0	0.0	0.0
Non-Project Sources				
RFD	6,224.2	55.5	48.1	48.1
RFFA	4,568.8	-1,394.3	-833.6	-330.0
State-permitted	2,868.0	118.2	-14.8	-133.1

[1] Non-Project emissions sources (RFD and RFFA) are described in Section 4.2.3; WDR = well development rate.

Predicted pollutant concentrations were compared to applicable ambient air quality standards, PSD Class I and Class II increments and were used to assess potential impacts to AQRVs--visibility (regional haze) and atmospheric deposition--at sensitive PSD Class I and II areas. The PSD Class I areas and sensitive Class II areas analyzed in the far-field analyses include:

- the Bridger Wilderness Area (Class I);
- the Fitzpatrick Wilderness Area (Class I);
- the Popo Agie Wilderness Area (Class II);
- the Wind River Roadless Area (Class II);
- the Mount Zirkel Wilderness Area (Class I);
- the Rawah Wilderness Area (Class I);

- the Savage Run Wilderness Area (Federal Class II, Wyoming Class I);
- Rocky Mountain National Park (Class I); and
- Dinosaur National Monument (Federal Class II, Colorado Class I).

Because emissions sources under the Proposed Action consist of many small sources spread out over a large area, discrete visible plumes are not likely to impact the distant sensitive areas. However, visible plumes may be noticeable within the ARPA and from nearby travel routes, especially during flaring upset conditions. Nonetheless, the potential for cumulative visibility potential impacts (increased regional haze) is a concern. Regional haze is caused by light scattering and light absorption by fine particles and gases. Potential changes to regional haze are calculated in terms of a perceptible "just noticeable change in visibility" when compared to background conditions. The BLM considers that a 1.0 dv change would be a reasonably foreseeable significant impact, although there are no applicable local, state, tribal, or federal regulatory visibility standards. Other federal agencies are using a 0.5 dv change as a screening threshold for significance. The USFS and NPS compare direct Project potential impacts to the 0.5 dv level and those comparisons are included in the Air Quality Technical Support Document (TRC EC 2004).

The NPS, USFS, and USFWS have published the *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report* (FLAG 2000) that prescribes a process for assessing the potential impacts of new and existing sources on AQRVs including visibility. The FLAG Report describes a cumulative potential impacts analysis of new growth sources (defined as PSD increment-consuming sources) on visibility. If visibility impairment from a proposed new source, in combination with cumulative new source growth, is less than an extinction of 10% (1.0 dv) for all days, the federal land managers would likely not object to the proposed new source. However, if predicted visibility impacts are above the visibility threshold, factors such as the magnitude of dv change, frequency, seasonal variations, and meteorological conditions may be considered when assessing the significance of predicted impacts.

A 1.0-dv change is considered a small but noticeable change in haziness as described in the EPA regional haze regulations (40 C.F.R. 51.300). One dv is defined as approximately equal to a 10% change in the extinction coefficient (corresponding to a 2-5% change in contrast for a "black target" against a clear sky at the most optically sensitive distance from an observer). This is a small but noticeable change in haziness under most circumstances when viewing scenes in mandatory Class I areas. However, this NEPA analysis is not designed to predict potential visibility impacts for specific views in mandatory Class I areas based on specific Project designs, but to rather characterize reasonable foreseeable visibility conditions that are representative of a large geographic region based on reasonable emission source assumptions. This approach is consistent with the nature of regional haze and the requirements of NEPA.

Potential changes in regional haze at PSD Class I and sensitive PSD Class II areas were estimated by comparing CALPUFF modeled impacts to background visibility conditions in the Class I or sensitive Class II area. This comparison was performed using two different representations of background visibility conditions. One method used visibility values provided in the FLAG Report for each Class I area to represent natural background visibility. The second method used estimated background visibility values from an analysis of recent long-term monitored data (1988–2002) from the IMPROVE program. This analysis consisted of estimating visibility parameters for representative Class I areas corresponding to the monitoring period of record quarterly average of the 20% best visibility days.

Fourteen lakes within the sensitive PSD Class I and Class II Wilderness Areas were identified as being sensitive to atmospheric deposition. These lakes are those for which the most recent and complete data are available, and include:

- Deep Lake in the Bridger Wilderness Area;
- Black Joe Lake in the Bridger Wilderness Area;
- Hobbs Lake in the Bridger Wilderness Area;
- Upper Frozen Lake in the Bridger Wilderness Area;
- Lazy Boy Lake in the Bridger Wilderness Area;
- Ross Lake in the Fitzpatrick Wilderness Area;
- Lower Saddlebag Lake in the Popo Agie Wilderness Area
- West Glacier Lake in the Glacier Lakes Ecosystem Experiments Site (GLEES);
- Lake Elbert in the Mount Zirkel Wilderness Area;
- Seven Lakes in the Mount Zirkel Wilderness Area;
- Summit Lake in the Mount Zirkel Wilderness Area;
- Island Lake in the Rawah Wilderness Area;
- Kelly Lake in the Rawah Wilderness Area; and
- Rawah Lake #4 in the Rawah Wilderness Area.

The NPS (2001) has identified Deposition Analysis Thresholds (DATs) for total nitrogen (N) and sulfur (S) deposition in the western U.S., which are defined as 0.005 kilograms per hectare per year (kg/ha-year) for both N and S. The DAT is used as an analysis threshold for evaluating the potential impacts from project-related emissions. The exceedences of this threshold trigger a management concern but are not necessarily indicative of an adverse impact (NPS 2004). The USFS (Fox et al. 1989) has defined 5 kg/ha-yr for S and 3 kg/ha-yr for N, as levels of concern for potential total deposition impacts, and these are used for comparison of potential impacts from cumulative source emissions. It is understood that the USFS no longer considers these levels of concern to be protective; however, in the absence of alternative FLM-approved values, comparisons to these levels are made. The USFS Rocky Mountain Region has also developed a screening method (USFS 2000) that identifies a Limit of Acceptable Change (LAC) in lake chemistry. The LACs are: 1) no more than a 10% change in acid-neutralizing capacity (ANC) for lakes with an existing ANC of 25 microequivalents per liter (μeq/l) or greater, and 2) no more than a 1-μeq/l change for extremely acid sensitive lakes where the existing ANC is below 25 μeq/l. Of the fourteen lakes identified by the USFS as acid sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive.

4.2.3 Alternative A – No Action

Near-Field Impacts

Air quality impacts would occur within the ARPA under the No Action Alternative due to the development of 720 wells on private and state lands. Near-field impacts from air pollutants emitted during construction and production operations, which were analyzed within the immediate vicinity of these activities, would be less than or equal to those impacts analyzed for the Proposed Action and documented in Section 4.2.2. Direct project impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ would be below applicable WAAQS, NAAQS, and PSD Increments.

Far-Field Impacts

Direct project far-field air quality impacts under the No Action Alternative, resulting from air pollutants emitted during the construction and operation of 720 wells, would be less than those

impacts analyzed for the Proposed Action and documented in Section 4.2.2. Direct project impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ would be below applicable WAAQS, CAAQS, NAAQS, and PSD Increments. There would be no adverse impacts to visibility at any of the analyzed sensitive Wilderness Areas. In addition, emissions from the No Action Alternative would result in an ANC change less than the LAC at analyzed acid-sensitive lakes, and predicted maximum S and N deposition impacts would be below the DAT at sensitive Wilderness Areas.

4.2.4 Proposed Action

Near-Field Impacts

The single phase of construction or production proposed as part of the Proposed Action that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of the Proposed Action modeled were: PM_{10} and $PM_{2.5}$ during construction of a well pad, SO_2 from drilling activities, and NO_2, CO, and HAP from production wells and compressor stations.

The predicted impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 are presented in Table 4-2 for comparison to the NAAQS and WAAQS. Maximum predicted concentrations of NO_2, CO, SO_2, PM_{10} and $PM_{2.5}$ were added to the ambient background pollutant concentrations, provided in Table 3-6, for comparison to ambient standards. O_3 maximum predicted concentrations were added to the average hourly background O_3 conditions monitored as part of the Green River Basin Visibility Study (ARS 2002) versus second high maximum values as presented in Table 3-6. The average value (75.2 $\mu g/m^3$) is consistent (slightly higher than) with the background ozone concentration of 62.6 $\mu g/m^3$ that was used in the RPM modeling to derive the Scheffe nomograph. In addition, the Scheffe method is a screening level modeling tool, and as such, it is overly conservative to add highest, second highest measured concentrations to screening level estimates. Predicted impacts from Proposed Action source emissions were shown to be below the applicable WAAQS and NAAQS. Table 4-3 presents a comparison of maximum predicted NO_2 impacts to the PSD Class II increment for NO_2. All NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment consumption analysis.

When reviewing the predicted near-field impacts, it is important to understand that the results reported reflect the maximum pollutant emission rates calculated for the field and that the resulting concentrations are combined with monitored background ambient pollutant concentrations. Monitored background air pollutant concentrations were assumed to occur throughout the LOP at all locations year-round. In addition, the maximum predicted air quality impacts from ARPA emission sources would occur in the vicinity of the ARPA; because potential impacts typically lessen with distance from an emissions source, potential impacts at locations more distant from the ARPA would be less than the predicted maximum concentrations. Finally, total air pollutant concentrations were assumed to be the sum of the maximum modeled concentration and the background concentration. This methodology is used for both long-term and short-term averaging periods. For short-term averaging periods, these maximum concentrations may occur under very different meteorological conditions and may not occur simultaneously.

Table 4-4 summarizes modeled HAP impacts based on emissions representative of the Proposed Action. All modeled acute and chronic impacts are below applicable health-based guidelines for the non-cancer compounds. Calculated cancer risk from formaldehyde and benzene are shown in Table 4-5. Both the incremental risk from benzene and formaldehyde

and the combined risk are less than the level of acceptable cancer risk of 1 x 10^{-6} for both the MLE and MEI scenarios.

Far-Field Impacts

Impacts from the Proposed Action maximum emissions scenario, which includes the last year of field construction, and nearly the full field in production, were modeled with CALPUFF. The emissions modeled are provided in Table 4-1. The maximum predicted concentrations, when added to ambient background pollutant concentrations, are below all applicable WAAQS, CAAQS, NAAQS, and PSD increments.

Direct visibility potential impacts from Proposed Action sources were predicted to be below the "just noticeable visibility change" (1.0 dv), at all sensitive Wilderness Areas using both the FLAG and IMPROVE background visibility data. The maximum predicted visibility change (0.2 dv) was predicted to occur at both the Savage Run Wilderness Area (both FLAG and IMPROVE background data) and Dinosaur National Monument (IMPROVE data only).

Table 4-2. Maximum Predicted Near-Field Impacts from Project Sources – Comparison to Ambient Air Quality Standards, Atlantic Rim Natural Gas Project.

Pollutant	Averaging Period	Maximum Predicted Impact of All Phases (µg/m³)	Background Concentration (µg/m³)	Total Predicted Impact (µg/m³)	NAAQS/ WAAQS (µg/m³)	Percent of NAAQS/WAAQS
NO_2	Annual	11.5	3.4	14.9	100	15
PM_{10}	24-Hour	20.8	33	53.8	150	36
	Annual	3.7	16	19.7	50	39
$PM_{2.5}$	24-Hour	7.0	13	20.0	65	31
	Annual	1.0	6	5.0	15	33
CO	1-Hour	222.6	3,336	3,559	40,000	9
	8-Hour	85.9	1,381	1,467	10,000	15
SO_2	3-Hour	20.2	132	152.2	1,300	12
	24-Hour	9.7	43	52.7	365 / 260	14 / 20
	Annual	3.2	9	12.2	80 / 60	15 / 20
O_3	1-Hour	23.0	75.2	98.2	235	42
	8-Hour	16.1	75.2	91.3	157	58

Table 4-3. Maximum Predicted Near-Field Impacts from Project Sources – Comparison to PSD Increments, Atlantic Rim Natural Gas Project.

Pollutant	Averaging Period	Maximum Predicted Impact of All Phases (µg/m³)	PSD Class II Increment (µg/m³)
NO_2	Annual	11.5	25

Table 4-4. Maximum Modeled HAP Impacts from Project Sources, Atlantic Rim Natural Gas Project.

Hazardous Pollutant	Air Averaging Period	Maximum Modeled Impact ($\mu g/m^3$)	Health Based Standards (Acute RELs and RfCs) ($\mu g/m^3$)
Benzene	1-Hour	926	1,300
	Annual	0.02	30
Toluene	1-Hour	1,414	37,000
	Annual	0.03	400
Ethylbenzene	1-Hour	154	35,000
	Annual	0.003	1,000
Xylenes	1-Hour	823	22,000
	Annual	0.02	430
n-Hexane	1-Hour	3832	39,000
	Annual	0.08	200
Formaldehyde	1-Hour	11	94
	Annual	0.003	9.8

Table 4-5. Long-term MLE and MEI Cancer Risk Analyses, Atlantic Rim Natural Gas Project.

Analysis	HAP Constituent	Modeled Concentration ($\mu g/m^3$)	Unit Risk Factor $1/(\mu g/m^3)$	Exposure Adjustment Factor	Cancer Risk
MLE	Benzene	0.019	7.8×10^{-6}	0.0949	1.39E-08
	Formaldehyde	0.0030	1.3×10^{-5}	0.0949	3.66E-09
Total Combined Risk					1.8×10^{-8}
MEI	Benzene	0.019	7.8×10^{-6}	0.71	1.04E-07
	Formaldehyde	0.0030	1.3×10^{-5}	0.71	2.74E-08
Total Combined Risk					1.3×10^{-7}

Direct Project source emissions from the Proposed Action would result in an ANC change less than the LAC at analyzed acid-sensitive lakes. The predicted maximum S and N deposition potential impacts from Proposed Action sources are below the 0.005 kg/ha-yr DAT at all the sensitive PSD Class I and Class II areas.

In-Field Impacts

The CALPUFF model was also used to predict maximum air quality impacts, from field wide emissions sources, at locations within and adjacent to the ARPA. The model-predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ at locations within and nearby the ARPA were added to monitored background concentrations and compared to applicable ambient air quality standards. The estimated Project-related potential impacts are below applicable ambient air quality standards.

4.2.5 Alternative B

Air quality impacts under Alternative B would be less than or equal to those predicted for the Proposed Action. The Proposed Action modeling analyzed a worst-case field development scenario; furthermore, any additional mitigation requirements due to the location of impacts from other resources would be expected to reduce air emissions below levels analyzed.

Near-field impacts would be less than NAAQS and WAAQS. Far-field concentrations would be below all applicable WAAQS, CAAQS, NAAQS, and PSD increments. Direct visibility potential impacts would be below the "just noticeable visibility change" (1.0 dv), at all sensitive Wilderness Areas using both FLAG and IMPROVE background visibility data. The predicted maximum S and N deposition potential impacts from Proposed Action sources are below the 0.005 kg/ha-yr DAT at all analyzed sensitive PSD Class I and Class II areas. ANC change would be less than the LAC at analyzed acid-sensitive lakes.

4.2.6 Alternative C

Air quality impacts under Alternative C would be less than or equal to those predicted for the Proposed Action. The Proposed Action modeling analyzed a worst-case field development scenario, and any limitation on field development schedule would be expected to reduce short-term and annual air emissions within the ARPA, which would in turn reduce short-term and annual air quality impacts. An extension of the LOP (with no change in total field development) would result in the same amount of air emissions as the Proposed Action over the longer LOP and, as a result, less air emissions annually.

Near-field impacts would be less than NAAQS and WAAQS. Far-field concentrations would be below all applicable WAAQS, CAAQS, NAAQS, and PSD increments. Direct project visibility impacts would be below the "just noticeable visibility change" (1.0 dv), at all sensitive Wilderness Areas using both FLAG and IMPROVE background visibility data. The predicted maximum S and N deposition potential impacts from Proposed Action sources are below the 0.005 kg/ha-yr DAT at all analyzed sensitive PSD Class I and Class II areas. ANC change would be less than the LAC at analyzed acid-sensitive lakes.

4.3 SOILS

4.3.1 Introduction

Potential impacts resulting from construction/installation of drill pads, pipelines, ancillary facilities, and access roads would include a loss/reduction of vegetation cover and biological soil crusts, exposure of vulnerable sub-surface soil profiles, loss/reduction of sub-surface biological components (i.e., earthworms, nematodes), undesirable mixing of soil horizons, soil

compaction, and loss of topsoil productivity. These impacts, singly or in combination, would increase the potential for valuable soil loss due to increased water and wind erosion, invasive/noxious/poisonous plant spread, invasion and establishment, and increased sedimentation and salt loads to the watershed system.

4.3.2 Impact Significance Criteria

The following criteria serve as a basis to assess the intensity, duration, and magnitude of potential soil impacts associated with implementation of the Proposed Action and Alternatives. Soil impacts would be significant given the following:

- Soil erosion is increased beyond two tons per acre per year within five years of disturbance;
- Interim reclamation is not successful within three years of implementation;
- Water Resources significance criteria are not met
- Vegetation significance criteria are not met
- Soil productivity is reduced to a level that prevents the disturbed area from recovering to pre-disturbance soil/vegetation productivity levels;

4.3.3 Direct and Indirect Impacts

4.3.3.1 Proposed Action

The Proposed Action and resulting construction and operation of wells, pipelines, roads, and facilities in the ARPA would result in adverse impacts to the soil resource by:

- Removal/damage of existing native vegetation and surface litter thus increasing wind erosion potential, increasing raindrop impacts to exposed soils and water erosion potential, and increasing soil surface temperature;
- Removal/damage of biological soil crusts;
- Removal/damage of topsoil and sub-soil fauna (macro- and microorganisms);
- Compaction of soils;
- Mixing of topsoil horizons, especially when mixed with sub-soils of high salt content; thus increasing topsoil salinity content;
- Increasing potential for undesirable (invasive/noxious/poisonous) plant invasion and establishment;
- Increasing potential for sedimentation/salt loads to the watershed, including stock ponds;
- Decreasing topsoil productivity.

As described in the Soil Section of Chapter 3, most soils in the ARPA have been mapped and sensitive soils identified. Implementation of the Proposed Action may occur in/on soils that have severe existing limitations. Table 3-10 summarizes the total area (acres) that may be affected by these limiting factors identified in the ARPA.

Because sensitive soil mapping units are widely distributed throughout the ARPA, total avoidance of these areas is not feasible. Minimizing the locations of facilities in sensitive areas to the maximum extent possible would be required to reduce adverse impacts to an acceptable level. Strict adherence to Best Management Practices/Conditions of Approval (Appendix H), the RMP, Non-point Source Pollution (Appendix J), and the Reclamation Plan (Appendix B) would be necessary to minimize adverse impacts. With these measures implemented, and

Over the estimated 20-year development phase, the Proposed Action is estimated to initially disturb a total of 15,800 acres which represents about 6% of the total land surface of the project area. During the projected 30-50 year life-of-project (LOP), the initial disturbed acreage would be gradually reduced to about 4,300 acres dependent upon time required for successful reclamation. Approximately 1050 total well locations would be developed in the first six years. The entire project area would be developed over a twenty year period, with approximately 95% of the CBNG wells and 75% of the conventional wells being drilled within 15 years.

A large portion of the project area would be difficult to re-vegetate due to high erosion potentials and poor topsoil. Some areas of clayey soils, sandy soils, and slopes > 25% would be avoided by final site choices during the onsite inspections for each year's development plan.

In general, the extent of these impacts to the soil resource would be influenced by the success of mitigation and reclamation efforts. Reclamation success, in part, depends on the amount of surface area disturbed, quality of topsoil salvaged, stockpile/redistribution methods in disturbed areas, precipitation, soil type, and moisture availability.

Despite the difficulty of establishing vegetation on sites with <10 inches average annual precipitation, current technology exists to stabilize these areas and minimize soil erosion as natural succession returns the site to pre-existing conditions. The reclaimed areas within the interim drilling PODs have not shown this success to date, however. There are many disturbed areas with increased erosion, weed infestations, and low native vegetation cover. Erosion could be reduced and reclamation success improved, assuming construction, maintenance and operation of well pad sites and associated disturbances are in accordance mitigation measures in Chapter 2, BMPs, and the RMP requirements. The increased pace of development would intensify the rate of soil exposed and the need for reclamation. Many areas would exceed the significance criteria for soils; therefore the project would exceed the significance criteria.

Surface disturbing activities have the potential to disturb or destroy biological soil crusts, if they are present. Loss of biological soil crusts by burying is inevitable with road construction, trenching, and other operations that remove vegetation and top soil. Disturbance to biological soil crusts can be minimized by limiting off-road vehicle activity (especially heavy construction equipment, trucks, pickup, and cars). Vehicle tracks often channel water resulting in slowing or preventing crust recovery and increasing erosion potential. Vehicles with high-flotation tires (e.g. all-terrain vehicles or ATVs) exert less force to the soil surface but may still disrupt crusts by rapid turns which shear the topsoil. A one time pass with vehicles crush them and still result in a long-term loss; the length of time necessary to allow recovery is unknown but is estimated at 50-100 years (Belnap 2001). If crusts are removed or buried, recovery time is anticipated to be longer.

4.3.3.2 Alternative A – No Action

Under the No Action Alternative, direct and indirect disturbance of soil and crusts would continue under the interim drilling plan. The remainder of the project area soils would remain unaffected. Given the success of reclamation and weed control efforts during the interim drilling period to date, areas are exceeding the significance criteria for soils.

4.3.3.3 Alternative B

The Temporal Development alternative is the same as the Proposed Action in terms of number of wells drilled and the acres disturbed both short-term and long-term. The principle difference with the Temporal Development alternative is that the majority of disturbance would occur in phases, with the middle area first, followed by the northern then southern portion in subsequent order. Half of the proposed wells would be drilled within the first six years, only within eight sub-watersheds; however, the majority would be in one, Dry Cow Creek. This concentration of development would likely increase runoff and sediment/salt yields beyond the water resources significance criteria. Impacts would exceed the significance criteria for soils. Impacts to crusts would essentially remain the same as described under the Proposed Action.

There may be some benefits to soils related to concentrated development on a regional basis. This method of developing all wells, roads, pipelines and facilities at the same time may result in better planning, reduced well pad locations, and acreage of disturbance.

4.3.3.4 Alternative C

The Spatial Development alternative would proceed with development across the ARPA similar to the Proposed Action, but additional mitigation proposed by soils and other resources would limit the initial disturbance acres on sensitive sites to less than 20 acres per section. Additionally, pad locations would be reduced to 4 per section. Examples of some sensitive sites are: soils with high runoff potential and big game crucial winter range. These would reduce the total acres disturbed by 64 percent compared to the proposed action. Other mitigation measures proposed would further reduce erosion from disturbed sites.

These benefits would be realized to the greatest extent in the central and southern portions where there is a preponderance of BLM lands. The extreme southern portion and the northern half would realize some benefit of these additional mitigations, but their effectiveness would be reduced due the lack of equivalent mitigation on private and state lands.

This reduction in disturbance acres and application of erosion control techniques would directly reduce the acreage which would exceed the significance criteria as a result of the project. Although some small, localized areas still would exceed the criteria, overall, the project would not exceed the significance criteria.

4.3.4 Impacts Summary

With implementation of the Proposed Action, potential impacts would be reduced assuming construction, maintenance and operation of well pad sites and associated disturbances are in accordance with BMPs and the RMP requirements. Many areas would exceed the significance criteria for soils; therefore the project would exceed the significance criteria.

With implementation of the No Action Alternative, significance criteria would be exceeded.

With implementation of Alternative B, the majority of the impacts would occur in one sub-watershed, resulting in exceeding the significance criteria.

With implementation of Alternative C, impacts would be reduced in extent compared to the proposed action as 36% of the acreage of sensitive soils on public lands would be disturbed. This reduction in disturbance acres and application of erosion control techniques would directly

reduce the acreage which would exceed the significance criteria as a result of the project. Although some small, localized areas still would exceed the criteria, overall, the project would not exceed the significance criteria.

4.3.5 Additional Mitigation Measures

There is no additional mitigation proposed under Proposed Action:

There is no additional mitigation proposed under Alternative B:

Additional mitigation proposed under Alternative C:

- Restrict development to <20 acres total disturbance and 4 pad locations per section for soils with high runoff potential
- Crimp mulch to increase surface roughness on soils with high runoff potential and poor/fair topsoil ratings
- Require reclamation within one year of spud date on soils with poor/fair topsoil ratings
- Apply soil amendments to improve reclamation success on soils with poor/fair topsoil ratings

4.3.6 Residual Impacts

Under the Proposed Action and Alternative B, there would be small areas along roads and well pads with erosion rates and sedimentation/salt yields exceeding the significance criteria.

Under Alternative C, there would be fewer areas, as compared to the proposed action, with erosion rates exceeding the significance criteria.

4.4 WATER RESOURCES

4.4.1 Introduction

The Clean Water Act of 1987, as amended (33 U.S.C. 1251), established objectives to restore and maintain the chemical, physical, and biological integrity of the nation's water. The act also requires permits for point source discharges to navigable waters of the United States and the protection of wetlands, and includes monitoring and research provisions for protection of ambient water quality. Wyoming Water Quality Regulations implement permitting and monitoring requirements for the Wyoming Pollutant Discharge Elimination System (WYPDES), operation of injection wells, groundwater protection requirements, prevention and response requirements for spills, and Water Quality Standards for Salinity in Colorado River System as recommended by the Colorado River Basin Salinity Control Forum and adopted by the State of Wyoming, Department of Environmental Quality.

Protection of Wetlands (EO 11990) requires federal agencies to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Floodplain Management (EO 11988) provides for the restoration and preservation of national and beneficial floodplain values, and enhancement of the natural and beneficial values of wetlands in carrying out programs affecting land use. Potential project related depletions to the Little Snake River are considered with regard to the Yampa River Basin

Management Plan and the recovery program for Colorado River native fish downstream (http://www.r6.fws.gov/crrip/).

Surface discharge from Federal Mineral Leases managed by the BLM, is subject to BLM approval. Once surface discharge is approved the operations from the point of discharge downstream are under the jurisdiction of EPA or the primacy State. In the general requirements section of Onshore Order #7 the following BLM regulations (bold and italics added):

> All produced water from Federal/Indian leases must be disposed of by (1) injection into the substance; (2) into pits; or (3) other acceptable methods approved by the authorized officer, including surface discharge under NPDES permit. ***Injection is generally the preferred method of disposal.*** **43 CFR 3160**

Below is an excerpt from Onshore Order #7, concerning surface discharge (bold and italics added):

> ***Operations from the point of origin to the point of discharge under the jurisdiction of the BLM.*** Operations from the point of discharge downstream are under the jurisdiction of EPA or the primacy State. **43 CFR 3160**

Some of the regulations described above require that certain permits/authorizations be obtained for project authorization including WYPDES permits for surface discharge of produced water; development of a surface runoff, erosion, and sedimentation control plan; oil spill containment and contingency plan; as well as CWA Section 404 permits in the Colorado River and North Platte River Drainage Basins. Since the Great Divide Basin is unconnected to navigable surface waters it is not subject to CWA Section 404 permits according to current court rulings.

For the purpose of analysis all actions and alternatives would be assumed to adhere to these plans and regulations for the protection of water resources. Discussions about how this would occur would be included in this section in regard to potential impacts to water resources.

Two BLM alternatives would be considered along with the proposed and no action alternatives. Many adverse impacts associated with gas development would be common to all alternatives and therefore would be analyzed for general impacts in section 4.4.3. As these impacts vary by alternative and can be expanded on they would be discussed in relation to each alternative.

4.4.1.1 Introduction to Surface Water Impacts

Potential impacts that would occur to the surface water system due to the proposed project include increased surface water runoff, wind erosion, and off-site sedimentation due to soil disturbance associated with construction activities (Soils Section 4.3), water quality impairment of surface waters, and stream channel morphology changes due to road and pipeline crossings. The magnitude of the impacts to surface water resources would depend on the proximity of the disturbance to a drainage channel, slope aspect and gradient, degree and area of soil disturbance, soil character, and duration of time within which construction activities occur, and the timely implementation and success/failure of mitigation measures. Impacts would likely be greatest shortly after the start of construction activities and would likely decrease in time due to stabilization, reclamation, and revegetation efforts (see Appendix B, H and J). Changes in surface flow patterns from road construction would continue through the live of the project and may extend beyond the project life if these roads are left in place. Petroleum products and other chemicals could be accidentally spilled resulting in surface water contamination. If these

spills occur they would be addressed with the Hazardous Materials Management and Release Contingency Plans for the Atlantic Rim Project.

4.4.1.2 Introduction to Groundwater Impacts

The primary effects on groundwater resources would be associated with the removal of groundwater contained in coal seam aquifers and the subsequent recharge of aquifers through injection of produced water. The removal of groundwater from the coal aquifer results in the reduction of the hydraulic pressure head. The hydraulic pressure head is the vertical distance between the static water level in a well and the top of the confined aquifer that the well is completed in. The lowering of water levels in an aquifer is also referred to as drawdown. The effects would result in progressive drawdowns within nearby wells completed in the same coal seam aquifers and/or the interruption of groundwater flow to existing nearby springs, seeps and flowing artesian wells receiving groundwater from the same coal aquifer. Another impact of the proposed project on groundwater resources, albeit minimal and relatively insignificant, would be an increase in the hydraulic pressure head in the aquifers receiving the injected coal bed water.

4.4.1.3 Assumptions for Analysis

Applicant committed measures (described in Appendix K), required BMPs (Appendix H) and BMPs for Non-Point Source Pollution (Appendix J) as applicable, as well as the regulation and plans described in Introduction would be adhered to under all alternatives. The ARPA presently contains several active fields, currently there are 210 active producing natural gas wells with accompanying production-related facilities, roads, and pipelines. While the ARPA environmental analysis is being prepared, BLM has allowed the interim drilling of a maximum of 200 natural gas wells, of which only 116 were drilled in nine POD locations specifically for the purpose of data acquisition necessary for the completion of the Atlantic Rim EIS.

The no action alternative as described in Chapter 2 would deny the proposed action. The existing pods would continue to be developed as described in the EAs for each pods (see Table 1-3. Current POD Status and General Location). Impacts would be similar to those described in the EAs for the pods and new proposals for developing gas leases in the project area would be considered as they are proposed. If impacts become significant for these proposals a new EIS process may be initiated.

All Action alternatives assume the construction of 2,000 wells and associated roads and pipelines based on the drilling schedule shown in Figure 4-6: Proposed Action Annual Drilling Assumptions by Well Type. The specific location of these facilities has not been provided by the operator under any alternative. The proposed action includes well pad locations in the modified EIS boundary described in Appendix K and would potentially be developed with 8 well pad locations per section anywhere within this boundary. This would result in approximately 3,420 (428 mi^2 x 8) potential well pad locations to analyze. As of 2005, there have been approximately 210 existing wells and 200 allotted for the interim drilling period. The proposed new well pad locations are 2,000 (CBNG and Conventional), this means that there are about 1,000 well pad locations that would not be used in the modified EIS boundary under all of the action alternatives.

Alternative B (Temporal Alternative) concentrates impacts into the middle, northern and finally the southern portion of the proposed action boundary. Impacts of individual well pads, roads, pipelines and other infrastructure would have the same impacts as the proposed action, their location and timing however would allow for economies of scale and potentially better planning.

Alternative C (Spatial Alternative) would not allow pad sites in some areas of environmental concern and would institute development protection measures that are based on resource concerns identified using spatial data (Geographic Information Systems). Many of these protection measures are specifically designed to reduce impacts to surface and ground water resources. Where these development protection measures don't apply impacts from individual well pads, roads, pipelines and other infrastructure would have the same impacts, this includes private and state lands.

4.4.1.3.1 Surface Water Assumptions

The analysis for surface water is based on the following specific assumptions:

- Disturbance to soil and vegetation, including compaction of soil or changes in vegetative cover, would increase water runoff and downstream sediment loads, and lower soil productivity thereby degrading water quality, channel structure, overall watershed health in some locations. The significance of this impact would depend on the alternative selected.

- The degree of impact attributed to any one disturbance or series of disturbances is influenced by several factors including location within the watershed, time and degree of disturbance, existing vegetation, and precipitation.

- Increased pollutants in surface waters would degrade habitat used by aquatic life and would affect other beneficial uses (e.g., stock-watering, irrigation, and/or drinking water supplies).

- BLM would continue to develop and maintain water sources in the uplands as a critical tool for managing grazing animals to reduce impacts on wetland/riparian areas.

- Access roads would follow standard practices. However, properly designed roads would still alter hillslope hydrology and concentrate overland flow in some areas. In areas with steep topography, these impacts would increase.

- Fine-textured soils are more susceptible to water erosion and compaction when wet, whereas coarse-textured soils are more susceptible to wind erosion (See Section 4.3 Soils).

The surface water analysis would look at 3,000 potential new well pad locations within the proposed action boundary, with only 2,000 actually constructed under all action alternatives. As described earlier the locations of these new pad locations can not be determined definitively under any of the action alternatives, therefore under each alternative assumptions for pad placement would be made.

4.4.1.3.2 Groundwater Assumptions

For the purposes of analysis the no action alternative for groundwater would only consider the impacts of approved development within the project area. This would include 210 conventional wells and 200 CBNG wells as described in the Interim Drilling Period (Appendix A). The

location of these wells would be in the originally approved POD boundaries and would include 1 injection well for every 12 CBNG wells.

For the purposes of analysis the potential locations of CBNG wells were determined to run the groundwater model. Assumptions were made based on the geology and unit boundaries described by the operator early in the process. The groundwater modeling assumptions are discussed in Section 4.4.3.

4.4.2 Impact Significance Criteria

Significance criteria are developed to gauge the magnitude an impact would have on the human environment. An adverse impact on water resources as a result of project actions would be considered potentially significant if its magnitude was such that special mitigation is warranted or it persists indefinitely.

Determining significance is complex, in that impacts are dynamic and may change during the planning period. Significance can be real and supportable by fact, or perceived and perhaps not fully supportable even with rigorous study. For this analysis, the approach to establishing significance criteria was based on legal issues (i.e., government regulatory standards), public perception, available scientific and environmental documentation, and professional judgment of resource specialists.

4.4.2.1 Surface Water Significance Criteria

Impacts to surface water resources would be considered significant if the following were to occur:

- Degradation of water quality beyond the designated use of the receiving water body, or other violations of federal or state water quality standards or negatively impacting a water body listed on the State 303d list of Impaired or Threatened Waterbodies.
- Increasing salt loading to the Colorado River System above background conditions.
- Unmitigated loss of wetlands or wetland function (EO 11990 and 11988).
- Project related activities that degrade wetland/riparian areas such that, as a minimum physical state, Proper Functioning Condition (PFC) is not being maintained.
- Streamflow characteristics of intermittent drainages or perennial streams are altered such that established users are affected.
- Accelerated erosion and runoff alters the physical characteristics of streams or drainages, beyond what would be expected with natural processes.
- Alteration of stream channel geometry or gradients that causes undesirable effects such as aggradation, degradation, or side-cutting.
- Disturbed areas are not adequately stabilized and accelerated erosion and runoff into intermittent drainages and perennial streams cause increased sedimentation that degrades the quality of water to the extent that does not support its designated use.

- If any of the actions would lead to non-compliance with regulations or plans described in 4.4.1 Introduction or Standards for Healthy Rangelands (BLM, 1997).
- Accidental spills of fuels, liquids, chemicals, or hazardous material affects the quality of surface water.

4.4.2.2 Groundwater Significance Criteria

Impacts to groundwater resources or springs would be considered significant if the following were to occur:

- The natural flow of groundwater to existing local springs, seeps, and flowing artesian wells is interrupted, regardless of use or non-use.
- Groundwater quality in any aquifer is degraded such that it can no longer be classified for its current use(s).
- The depth to groundwater is increased to a level that would require replacement or deepening of WSEO-permitted water wells in the project area (see Appendix H).

4.4.3 Direct and Indirect Impacts

4.4.3.1 Direct and Indirect Impacts Common to All Action Alternatives

The proposed new well pad locations are 2,000 (CBNG and Conventional) under all alternatives, this means that there are about 1,000 well pad locations that would not be used in the modified EIS boundary under all of the action alternatives. Under all the action alternatives, impacts of individual well pads, roads, pipelines and other infrastructure would have the same individual impacts if no specific mitigation is applied for these locations.

Between the time that the groundwater model was constructed and the Draft EIS was written, the proposed ARPA boundary was changed. The boundary change would not affect the groundwater model within the northern portion of the ARPA. However, within the central portion of the ARPA, the new boundary extends into some of the modeled wells. These wells would need to be moved in subsequent model runs. This would change the spatial distribution of wells, which would likewise change the shape of the drawdowns. Because in general the drawdowns do not propagate long distances, the drawdown figures within the EIS are not expected to change significantly. However, by moving the wells further into the basin and away from the outcrop, the recovery time for the project may increase; yet at the same time there is likely to be fewer impacts on the contact springs. The net change is not expected to change the impact analysis, even though the temporal distribution of the changes would be slightly different.

All action alternatives would remove water from the coal seams in the Mesaverde Formation and would result in lowering of pressure within the formation with associated impacts. These would be in slightly different locations and at different times depending on the action alternatives.

4.4.3.1.1 Surface Water Impacts Common to All

The main impacts of the project related to surface water resources are the removal of vegetation, increased soil surface exposure, mixing of soil horizons, soil compaction and decreased infiltration capacity, loss of topsoil productivity, and increased susceptibility of the soil to wind and water erosion. Therefore, the primary impact of the proposed project on surface water resources is increased surface runoff, erosion and off-site sedimentation that would cause channel instability and degradation of surface water quality in some locations.

4.4.3.1.1.1 Surface Hydrology Related to Soils Data and Topography

Soils with the potential for severe water erosion about comprise about 85% of the ARPA (261,000 acres of slight/severe, moderate/severe and severe/severe categories, see Table 3-13 and 3-14. Areas of Soil Factors of Concern). These tables summarize the data for these five categories (water erosion, wind erosion, runoff potential, topsoil rating, and road rating) and their individual ranking criteria for the contiguous ARPA. Since so much of the ARPA has the potential for severe water erosion, soil disturbance both during construction and during production can be expected to result in hillslope and channel erosion under each alternative above background conditions. Erosion in areas with sensitive soils can be either catastrophic or simply chronic. Surface disturbance combined with sensitive soils and highly variable precipitation can result in sudden and dramatic erosion in the form of rilling and gullying, even in relatively gentle terrain. These catastrophic failures can produce very high quantities of sediment and can appear to be random and unpredictable.

Soil depth ranges from shallow to deep, soil drainage from somewhat poor to somewhat excessive, permeability ranges from slow to rapid, water capacity ranges from very low to high, runoff from slow to rapid, and susceptibility to water erosion ranges from slight to very severe. The diversity of soil parameters would require a broad spectrum of reclamation techniques. In addition, low annual precipitation and wind and water erosion could make successful reclamation in the ARPA difficult to attain. Therefore, the overall potential for successfully stabilizing disturbed soils is poor to fair.

Slopes rated strong (15%) or greater occupy at least 21 percent (65,000 acres) and a much smaller percent of residual slopes and flats within the overall project area. In nearly half of the instances of strong slope, shallow depth to rock and/or high sand content may be anticipated as a further complication.

Since specific sites have not yet been identified for wells, pipelines, and roads, Tables 3-10 and 3-11 indicate a likelihood of encountering soil limitations that would require special attention. For example, large portion of the ARPA would likely experience difficulties during revegetation due to the presence of excess salts and/or clay in the soil.

4.4.3.1.1.2 Reclamation Success and Roads

It is important to note that even successful reclamation does not necessarily return an area to its previous function for surface hydrology. This is because perennial forbs, brush and trees generally are more effective at reducing rain splash and can provide structure on the soil surface that can reduce surface runoff energy, but are generally not required for reclamation. Anderson (1975) in a study of 23 watersheds found that conversion of a steep forest and brush lands to a grassland had multiplied sediment yields by 5 times. All though this is an extreme case, it points out that not all vegetation is the same hydrologically. Some areas where interim

reclamation has been successful may begin to get sagebrush and other brush regeneration within the project life, however many areas would not return to pre-disturbance function until 30 – 50 years after final reclamation.

New access roads would be constructed for the purpose of natural gas field development. There are three type of roads identified for the project. Collector and local roads are to access multiple well pad locations and resource roads are to access individual well pads. As described in the applicant committed measures (Appendix K), roads would be designed to BLM Manual 9113 standards and to minimize disturbance, and all surface disturbance would be contained within the road ROW. In the event drilling is non-productive, all disturbed areas, including the well site and new access roads, would be reclaimed to the approximate landform that existed prior to construction. If drilling is productive, all access roads to the well site would remain in place for well servicing activities. Partial reclamation would be completed on segments of the well pad and access road ROW no longer needed.

Road construction under all alternatives would modify the surface hydrology by intercepting and concentrating shallow groundwaters and increasing surface runoff. For example cut slopes can often capture soil macropores and road surfaces decrease infiltration and can concentrate flows. Roads would also contribute sediment to downstream drainages from the road surface and from surface disturbance based on construction and road maintenance activities. Properly designed roads would be more able to shed water in a non erosive manner and this would reduce impacts compared to roads that are improperly or inadequately designed. However, even with proper design using BLM Manual 9113 standards, there would be local impacts in terms of erosion and changes in hydrology. Where roads are in steep country and/or road densities are great these impacts can be expected to include accelerated erosion and increased runoff and could alter downstream stream channels significantly.

During drilling and completions operations, according to Table K-11 Traffic Estimates, roads could be used by about 13 heavy trucks per week for about two weeks, and about 5 to 10 small trucks per day. During production resource roads would be used less often (maybe 1 small truck per day) and would occasionally accommodate heavy trucks for water disposal, reclamation activities, and well maintenance. This means that road design needs to allow for heavy truck traffic and at least on visit per day in all kinds of weather. Road design and maintenance is therefore critical to reduce impacts from the project.

Site erosion and off-site sedimentation from pad sites would be reduced by revegetating unused portions of the pad sites in the first appropriate season (fall or spring) after drilling, and providing surface water drainage controls, such as berms, sediment collection traps, diversion ditches and erosion stops as needed. These measures would be described in the individual APD/ROW.

Under all action alternatives local impacts would include accelerated erosion and increased runoff leading to increased sedimentation and changes in hydrology from surface disturbance for the construction of pad sites, roads and pipelines. Depending on the alternative considered these impacts could be significant based on section 4.4.2 Impact Significance Criteria.

4.4.3.1.1.3 Surface Water Quality Impacts from Salinity Offsets

Surface discharge at the Cow Creek POD can be expected to continue through the life of the project under all alternatives according to the WYPDES permit # WY0042145 and #WY0035858 which allows for 1.34 tons/day and 180,600 gallons/day of total discharge under both permits. As an offset for an oil well (as defined by the Colorado River Salinity Control Forum) and the

permit allows for the same volume of water and salt as was discharged by the oil well plugged (#1X-12).

This discharge is in to a reservoir on a tributary to Dry Cow Creek; this reservoir would be improved and maintained according to this use. The discharge permit is currently being modified to allow for water releases from the reservoir in a similar manner as what occurred historically when #1X-12 was in operation; however volume restrictions would still be in place. The permit would have a new point of compliance upstream of the confluence with Cow Creek. This point of compliance would be monitored for flow, according to the permit it should only have water during storm events, i.e. in response to natural precipitation and not a result of project discharges since Dry Cow Creek is ephemeral.

The Colorado River Salinity Forum established by the 1974 Colorado River Basin Salinity Control Act, Public Law 93-320 regulates in terms of salt loads. Current loads approved by the State exceed the 1 ton per day limit because of the offset value of plugging #1X-12. Allowing for offsets with volume restrictions limited to historical levels with flowing wells is not expected to have any significant impacts, since project related discharges would be almost identical to current conditions.

4.4.3.1.2 Groundwater Impacts Common to All

The primary effects on groundwater resources would be associated with the removal of groundwater contained in coal seam aquifers and the subsequent recharge of aquifers through injection of produced water. The removal of groundwater from the coal aquifer results in the reduction of the hydraulic pressure head. The hydraulic pressure head is the vertical distance between the static water level in a well and the top of the confined aquifer that the well is completed in. The lowering of water levels in an aquifer is also referred to as drawdown. The effects would result in progressive drawdowns within nearby wells completed in the same coal seam aquifers and/or the interruption of groundwater flow to existing nearby springs, seeps and flowing artesian wells receiving groundwater from the same coal aquifer. Another impact of the proposed project on groundwater resources, albeit minimal and relatively insignificant, would be an increase in the hydraulic pressure head in the aquifers receiving the injected coal bed water.

Between the time that the groundwater model was constructed and the Draft EIS was written, the original proposed ARPA boundary was changed. The boundary change would not affect the groundwater model within the northern portion of the ARPA. However, within the central portion of the ARPA, the new boundary extends into some of the modeled wells. These wells would need to be moved in subsequent model runs. This would change the spatial distribution of wells, which would likewise change the shape of the drawdowns. Because the drawdowns do not propagate long distances, the drawdown figures within the EIS would not change significantly. However, by moving the wells further into the basin and away from the outcrop, the recovery time may increase; yet have less impact on the contact springs. The net change would not be significant, only the temporal distribution of the changes would be slightly different.

Groundwater could also be affected during construction of drill pads and wells or by other project development activities. Improper casing and cementing of wells, undetected spills, or leachate from produced water or mud pits could introduce contaminants into the groundwater. Chemicals used for production drilling could cause local contamination of soils and groundwater if not managed properly. Construction of drilling pads, proper disposal practices, proper well casing and cementing, and recycling of drilling fluids would be in accordance with BLM guidelines and should minimize adverse effects on groundwater quality. If accidental spills occur

they would be addressed with the Hazardous Materials Management and Release Contingency Plans for the Atlantic Rim Project (Appendix C).

Appropriate measures would be taken during project development to prevent adverse impacts on existing groundwater quality during dewatering. Given the present state and federal regulations regarding general water quality, as well as salinity in the Colorado River Basin, surface discharge of produced water is not anticipated. Water would be used during construction, drilling activities, and dust abatement subject to State permits. Most of this water would come from the Coalbed Natural Gas wells however the source of this water, particularly for construction and dust abatement may come from sources that could impact surface resources. Therefore, water to be used for construction and dust abatement was estimated and depletions consulted on with the Fish and Wildlife Service in regard to the Upper Colorado Endangered Fish Recovery Program. Water produced from coal seams is assumed to be unconnected to surface water based on isotopic analysis, groundwater modeling and water quality characteristics.

If accidental surface discharges occur, they could adversely impact nearby surface water quality by increasing salinity levels. The extent of any impact would depend on the quality and quantity of the produced water and any fluids being released and would be addressed with the Release Contingency Plan.

4.4.3.1.2.1 Water Disposal Using Injection

Produced water would be disposed in underground injection wells, except in the case of the Cow Creek POD that has a surface discharge WYPDES permit that allows for the discharge of produced water as an offset for a flowing well (#1X-12) that was plugged in the same area. The conditions of this permit allow for the same volume of salt and water to be discharges as what would have occurred had not the well been plugged. Produced water would also be used for drilling, construction, dust abatement, and other project related water uses subject to approval from the State of Wyoming for this use. Water could also be used in closed-system stockwatering tanks. None of these uses would be for water disposal needs; primary water disposal would be through injection wells.

The underground disposal of produce water would be accomplished using deep injection wells. Depth of the injection wells, which would be completed in the Hatfield, Cherokee, and/or Deep Creek Sandstones, is expected to range from 3,200 to 6,400 feet. All injection wells would have permits prepared and submitted to the WOGCC and SEO. The only effect on the injection horizons would consist of an increase in the hydraulic head emanating from the injection well, which would dissipate with distance away from the well bore.

Produced water would be collected in a buried polyethylene flowline (pipeline) for transport to an injection well. Centrifugal pumps, reciprocating pumps, filter systems, and tanks at the disposal facility would be used to remove solids from the water stream and to pump the water at pressures sufficient to allow downhole disposal. In the event that an injection well ceases to operate properly due to formation over-pressuring or mechanical failure, the operator must still remain in compliance with all applicable regulations governing the operation of the produced water disposal system. Compliance options available to the operator include curtailing or halting the rate of water production or routing the discharge to additional injection wells.

Each deep injection well would have an approximate minimum injection capacity of 5,000 bbls/day and a maximum injection capacity of 15,000 bbls/day. A predicted volume of produced

water in the best success scenario for the proposed well development would be 250,000 to 450,000 bbls/day for approximately 6 to 8 years. The volume of water would be on a consistent decline as the coal seam is dewatered.

The deep injection wells would be drilled, cased, and cemented from total depth (approximately 50 feet below the base of the Hatfield, Cherokee, or Deep Creek Sandstones) to the surface. These sandstone units are isolated above by the Lewis Shale and below by the Baxter or Steel Shale, which are thick, competent marine clays that are effective barriers to groundwater flow. The deep sandstones would be tested to evaluate suitability for disposal before any water is injected. Maximum pressure requirements to prevent initiation and propagation of fractures through overlying strata to any zones of fresh water have also been determined and would be regulated by the State of Wyoming and the BLM. The results of the open-hole log and injectivity test would be provided to the regulatory agencies. The injectivity tests would be used to determine the fracture pressure limits that would be imposed to insure the overlying and underlying shale is not breached. The fracture gradient of the shale aquitards that overlie and underlie the injection horizons would not be exceeded based on injectivity tests and applicable permit limits. Thus, all injected water would be contained in the injection horizon and would not migrate vertically.

In summary, groundwater would be removed from a formation that is stratigraphically lower and hydraulically isolated from shallow groundwater sources that have been or are most likely to be developed by water wells used for purposes other than CBNG development. The proposed injection zone is stratigraphically lower than the shallow groundwater sources. Shallow groundwater sources (stratigraphically above the Mesaverde coal zones) are not likely to be affected by the project.

4.4.3.1.2.2 Groundwater Quality

Well drilling and completion should not have an adverse effect on existing groundwater quality if the project is in compliance with "On-Shore Oil and Gas Order No. 2". However, poor drilling and completion techniques could result in degradation of groundwater quality due to the mixing of variable quality waters from different water-bearing strata that happen to be pierced by the borehole. The magnitude of mixing, if any, which would occur during the relatively short period of time during drilling would be relatively small. In addition, due to the state-of-the-art drilling and well completion techniques, the possibility of significant degradation of groundwater quality in any aquifers is low.

Well completion must be accomplished in compliance with "Onshore Oil and Gas Order No 2". These guidelines specify the following:

"...proposed casing and cementing programs shall be conducted as approved to protect and/or isolate all usable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use."

Usable water is defined as groundwater with a TDS of 10,000 ppm or less encountered at any depth. To comply with the order, wells must be completed such that either usable water is isolated from "unusable" water, or that unusable water is isolated from usable water through the use of cementing and other proven technologies. Assuming compliance with this order, no contamination of usable groundwater would likely occur. Well drilling and completion as proposed in Chapter 2 appears to comply with the on-shore order.

Injection of the CBNG-produced water is not expected to result in any deterioration in groundwater quality within the injection horizon. The proposed injection targets have been water quality tested to evaluate suitability for disposal, and the results show that groundwater to be of lower quality than the produced water from the coal beds of the Mesaverde Group. Sandstone strata of the injection zones are isolated above and below by competent shale barriers that would prevent the infiltration of the injected water into any overlying fresh water zones. BMPs would be implemented to ensure surface spills of produced water do not occur. All water disposal plans would be permitted with the state agency that regulates the facilities, including but not limited to the WOGCC and WDEQ/WQD.

The improbability of degradation of groundwater quality within any aquifers within and outside of the ARPA essentially eliminates the possibility of adverse effects to the area's groundwater right holders.

4.4.3.1.2.3 Springs and Seeps

The ARPA contains numerous springs, seeps, and flowing wells, which are important local water sources for livestock and wildlife. At least 16 flowing wells and 70 active springs are contained within the ARPA. Prolonged drought in southern Wyoming has reduced the number of seeps, especially in the Sand Hills portion of the project area, they are expected to recover along with the drought conditions.

Springs in the ARPA occur primarily at the contact between the Upper Cretaceous Mesaverde Group and the overlying Tertiary-age deposits of the Browns Park Formation. Springs also occur within the outcrop area of the Mesaverde Group itself. Springs located at the Browns Park/Mesaverde Group contact are far more common, generally have higher yields, and are of better water quality than those springs issuing from units within the Mesaverde Group. The quality of water sampled from many of the flowing wells in the ARPA indicates that the groundwater is from the Almond Formation coal seams. Groundwater level drawdowns in the Almond Formation coal seams resulting from the proposed project would likely cause a reduction or discontinuance of discharge from flowing wells that are completed in an affected coal seam aquifer.

Tertiary deposits in the ARPA near the surface are recharged by direct downward percolation of precipitation and snowmelt and from seepage losses from streams. Deep aquifers in the ARPA are also recharged by these processes in outcrop and subcrop areas and from slow leakage from overlying and underlying aquifers. The extent of the Tertiary units (Browns Park and North Park Formations) that lie atop the eroded, dipping Cretaceous units indicates a probable significant recharge of the underlying permeable Mesaverde Group exists at this angular unconformity-type contact area. Should groundwater withdrawals from Mesaverde Group coal beds in the ARPA result in water-level declines that propagate updip to their subcrop areas beneath the overlying Tertiary units, the Proposed Action could adversely affect some of the Cretaceous/Tertiary contact seeps and springs. However, the predicted groundwater drawdown analysis for this project does not indicate groundwater level declines would extend updip to the coal seam subcrop areas. Therefore, it is unlikely that the proposed project would have a dewatering effect on the overlying Tertiary deposits, which would diminish flows from the contact springs and seeps.

All construction activities and storage of petroleum products would be kept away from seeps and springs (a minimum distance of 200 to 600 feet depending on the type of spring). Therefore, contamination of seeps and springs and groundwater would be unlikely.

4.4.3.1.2.4 Flowing Wells

Flowing wells in the project area have been developed to supply water to wetland areas and stock watering facilities and may be impacted by reducing flow volumes or changing water quality characteristics. Many of these flowing wells are abandoned exploratory oil and/or gas wells that had some portion of the casing fail adjacent to strata under artesian pressure. It is likely that some of these flowing wells have casing failures adjacent to Almond Formation coal seams targeted by this project for production and therefore may be impacted by reducing flow volumes. The groundwater model predicts a 3 to 30% decrease in flowing well volumes by 2050, with full recovery in the year 3000 (WWC, 2005)

4.4.3.1.2.5 Water Rights Related to Groundwater

As discussed in Chapter 3, the SEO records identify 90 active permitted, non-CBNG-associated groundwater rights in the ARPA. Of the 90 permitted wells and springs, 58 reported positive yields, the majority of which are developed within the Mesaverde Group and the Browns Park Formation. Groundwater currently in use in the project area that is obtained from Tertiary-age units should not be adversely affected by groundwater level declines in the Mesaverde Group coal seams. Permitted water rights in the project area that obtains water from the Cretaceous-age coal seams that are dewatered by the proposed project may be adversely affected by the resulting groundwater level declines. However, the targeted coal seam aquifers are stratigraphically lower and hydraulically isolated from shallow groundwater sources that are typically developed and permitted with the SEO. This, combined with the improbable degradation of groundwater quality would essentially eliminate the potential occurrence of adverse impacts to groundwater right holders within and near the ARPA.

A numerical groundwater flow model was used to predict drawdown impacts to the groundwater system under the Proposed Action. Modeling was necessary because of the large extent of, variability in, and cumulative stresses imposed by development of CBNG on the coal seam aquifers of the Mesaverde Group. The assumptions used to support the predicted groundwater drawdown analysis, the computer model used in the analysis, and the predicted drawdown impacts for this project are describe in detail in the Atlantic Rim EIS Ground-water Modeling Technical Support Document.

4.4.3.1.2.6 Regional Groundwater Model Description and Findings

The regional model of groundwater flow for the ARPA is based on the geology and hydrogeology described in Chapter 3. The groundwater model encompasses the western flank of the Sierra Madres and extends into the Washakie Basin roughly 30 miles west of the ARPA. This model cannot be used to predict results at a localized scale and any attempts to do so would require additional data and additional modeling efforts. Between the time that the groundwater model was constructed and the Draft EIS was written, the original proposed ARPA boundary was changed. This could alter some of the groundwater modeling results, but should not result in appreciable changes that would change the impact analysis. The model would be re-run with the modified boundary for the Final EIS release. Atlantic Rim groundwater model Technical Report (WWC 2005) includes a detailed discussion on calibration of the groundwater flow model.

The hydrogeologic model code selected was the USGS Three Dimensional Finite Difference Modular Groundwater Flow Model, MODFLOW (MacDonald and Harbaugh 1988) and the pre/post processor, Groundwater Vistas (Rumbaugh and Rumbaugh 2002).

Hydrogeologic Groups in the ARPA

Within the ARPA, the Mesaverde Group strata dip westward off the Sierra Madre uplift at about 8 to 12 degrees. The total thickness of the Mesaverde Group is approximately 2,000 to 3,000 ft. The Mesaverde Group consists of four members, which in ascending order are the Haystack Mountains Formation, the Allen Ridge Formation, The Pine Ridge Formation, and the Almond Formation. The uppermost member, the Almond Formation, contains numerous carbonaceous shale intervals and coal beds. The lateral continuity of these coal units is considered sufficient such that they act as a regional aquifer system. Although individual coal seams may split and merge, there is sufficient hydraulic communication, on a regional scale, to allow movement of groundwater.

The coal-bearing Almond Formation ranges in thickness from 400 to 600 ft and occurs at depths of less than 100 ft in the center of the ARPA to about 1,800 ft below ground level along the western boundary. The Lewis Shale, which overlies the Almond Formation, reaches a thickness of 2,700 ft in the Washakie Basin and is consistently more than 2,000 ft thick in the ARPA except where it has been removed by erosion. The Lewis Shale is a low permeability unit considered to be a regional confining layer. Unconformably overlying the Cretaceous sediments is the Tertiary-age Browns Park Formation. Contact springs are relatively common at the base of the Browns Park Formation where it is in contact with the less permeable units of the Mesaverde Group. Due to the lack of contact between the Almond Formation and the Browns Park Formation, groundwater within the Browns Park could not be impacted by groundwater withdrawls from the Almond; therefore, the Browns Park Formation was not included in the model.

Assumptions for Groundwater

For the purpose of the modeling study, the primary unit of interest is the coal-bearing Almond Formation and Pine Ridge Sandstone of the Mesaverde Group. Specifically, the coal seams within the Almond Formation and Pine Ridge Sandstone are the aquifers of interest. Overlying the Almond Formation is the Lewis Shale, a regional confining layer. Underlying the Almond Formation is the Pine Ridge Sandstone and beneath the Pine Ridge is the Allen Ridge Formation, which is also considered a confining unit. Therefore, the Almond Formation and the underlying Pine Ridge Sandstone are primarily recharged from natural precipitation infiltration along their outcrop on the western flank of the Sierra Madres. The natural groundwater flow direction is then westward, down dip toward the basin center. Groundwater within the Almond coals is unconfined near outcrop recharge areas, but rapidly becomes confined away from the outcrop. The overlying Lewis Shale and underlying Allen Ridge Formations are sufficiently impermeable to prevent leakance into or out of the Almond Formation and Pine Ridge Sandstone. Infiltration of surface water that occurs in the small ephemeral and intermittent streams in the area can effectively be ignored in the model, as the streams are predominately located within the overlying Lewis Shale. Therefore, little if any recharge occurs anywhere other than the outcrop area.

A number of flowing wells completed within the Almond coals are located throughout the ARPA. Potentiometric data, albeit sparse, was compiled for the Almond coals in the ARPA and eastern Washakie Basin. A potentiometric surface map of the Almond Formation under current

conditions is included in the Atlantic Rim groundwater model Technical Report (WWC 2005). Hydraulic gradients are steeper near the outcrop and become less steep into the basin. In addition to the potentiometry data, drill stem test data and age-dating Almond coal groundwater indicate that groundwater velocities under natural gradient are extremely low.

The primary physical groundwater flow boundary is the Almond Formation's outcrop to the east. Near the center of the Washakie Basin, which would be along the western portion of the model domain, evidence suggests that there is little, if any, groundwater flow in the westward direction. Within the model, the western boundary is represented by a no flow boundary. The north and south boundaries are not marked by any natural geologic features, but are located far enough from the proposed production wells in the ARPA that their influence on the wells would be minimal. For this reason, the north and south edges of the model are artificial boundaries.

There is very little measured hydraulic conductivity data available for any of the five modeled layers within the ARPA. The hydraulic conductivities assigned to each layer were based on information that is presented in the Atlantic Rim groundwater model Technical Report (WWC 2005). To account for anisotropic conditions in the vertical direction, the vertical hydraulic conductivity would be 10 times less than the horizontal conductivity. Within the model, the hydraulic conductivity of the sand layers would vary based on the average hydraulic conductivity at burial depth. Like the sands within the Almond Formation, burial depth is assumed to affect hydraulic conductivity for the coals, with a lower value for the deeper coals and a higher value for the shallower coals. Coals would have slightly smaller hydraulic conductivity values than the sand units, but values would be varied with depth similar to the way hydraulic conductivity values for the sand units were varied.

The hydraulic connection between the sand layers and the coals is unknown. Locally, the hydraulic connection between the coal layer and sand layers may be enhanced if the integrity of the confining layer is compromised (e.g., by poorly plugged exploratory drill holes). Leakage from the sands into the coal production layer may also be enhanced if water levels in the coal are lowered as a result of dewatering. After a significant period of time (i.e., several years), a drawdown in the sands may become apparent due to the limited hydraulic communication between the coal and sand layers. There are three monitoring wells in the ARPA that were established during the interim drilling period and would be maintained through the life of the project. These monitoring wells would measure pressure in the producing coal seams and sand stone aquifers directly above and below the coal seam. At this time, there is very little reliable storativity or specific yield data for the modeled layers; therefore, values were based on USGS estimates, which are based on the thickness of the aquifer (WWC 2005).

Model Construction

The hydrogeologic model code selected was the USGS Three Dimensional Finite Difference Modular Groundwater Flow Model, MODFLOW (MacDonald and Harbaugh 1988) and the pre/post processor, Groundwater Vistas (Rumbaugh and Rumbaugh 2002). MODFLOW is a model code widely used and accepted by regulatory agencies and the BLM. Seven MODFLOW packages were used in the Atlantic Rim groundwater model (WWC 2005).

The model grid is oriented parallel to the geologic strike of the Almond Formation outcrop, which is generally north-south. The model area encompasses some 2,866 square miles. The regional model consists of five layers. The top layer represents the Almond Formation sandstones, the second layer represents the clay and siltstone parting below the Almond sandstones, the third layer represents the production coal packages within the Almond Formation and Pine Ridge

Sandstone, the fourth layer represents the clay and shale partings below the coal packages, and the fifth layer represents the Pine Ridge Sandstone sandstone units. The Lewis Shale acts as a confining layer above the Almond Formation and the Steel Shale acts as a confining layer below the Pine Ridge Sandstone. The model area is bounded on the east by the outcrop of the Almond Formation, on the west by a no-flow boundary, and due to the lack of natural geologic boundaries, prescribed constant head cells bound the north and south portions of the model domain.

The hydraulic parameters within the groundwater model area include hydraulic conductivity, storage, and recharge. Hydraulic conductivity is largely unknown in the model area and values assigned within the model were based largely on information obtained from testing conducted in oil and gas fields outside of the model area by the oil and gas industry, limited testing on coals within the ARPA, and testing of coals within the Powder River Basin in Wyoming. Based on bore hole logs within the ARPA, the bulk of the Almond Formation and Pine Ridge Sandstone is generally composed of sand, with the coals, siltstones, and shales making up a small portion of the formations. Within the model, the hydraulic conductivity of the sand layers would vary based on the burial depth (i.e., values decrease with depth). The hydraulic conductivity values assigned to the shales and siltstones were much lower than that of the sands and coals. Storage coefficients within the model were estimated based on the thickness of the modeled layer, which are from top to bottom: 420 ft, 30 ft, 50 ft, 30 ft, and 170 ft, respectively. To account for anisotropic conditions in the vertical direction, the vertical hydraulic conductivity was estimated to be 10 times less than the horizontal conductivity ($K_y = K_x = 10K_z$).

The principle source of recharge is natural precipitation infiltration at the Mesaverde Group outcrop on the western flank of the Sierra Madres. Within the model, recharge would occur within the portion of the Mesaverde Group containing the Almond Formation and Pine Ridge Sandstone and the total recharge would be 3 to 9 percent of the average annual precipitation.

Groundwater flow into the Washakie Basin is very sluggish, if it even occurs at all. Based on that information, it follows that there are no natural drains within the interior portion of the basin. The only natural drains to the system occur near the contact between the Mesaverde Group and the overlying Lewis Shale as springs. These contact springs were simulated in the model as drains inserted into the top layer. The only other drains within the model area are flowing wells completed in the Almond Formation. The flowing wells are discharging from the same coal seams that are proposed to be produced; therefore, they were inserted into layer 3. The locations and elevations of the springs and flowing wells were determined from U.S. Geological Survey mapping and Wyoming SEO records. Spring discharge rates were also determined from SEO records or assumed to be similar to that of nearby measured spring flows.

Limitations of the Model

Many of the assumptions and limitations within the modeling software are the result of the inaccuracies inherent in modeling a natural system and are generally similar for all modeling software. Limitations and assumptions specific to this modeling effort are primarily due to the paucity of physical and hydraulic characteristics of the aquifers and confining units in the regional model area, as described in detail in the Atlantic Rim groundwater model Technical Report (WWC 2005).

Simulation of the Projected Effects

The simulation portion of the model replicates the proposed development within the ARPA. Presently, the most severe development scenario projects that a maximum of 1,800 CBNG wells would be completed within the ARPA. Current production predictions estimate that the wells would produce water for 20 to 30 years, so the average life of water production for each well was 25 years and each drain simulating a well was left active for 25 years within the model. The development scenario assumes that wells within the interior portion of each unit would be developed first, with wells expanding concentrically from the center of the unit out to the edges of the ARPA boundary. After a drain was turned on, it was left on for 25 years. The modeled simulation period extends in five-year increments from 2005 to 2050, with the last production well being turned off in 2050. Drawdown contours from the projections within the five modeled layers at the end of each five-year period are shown in figures included in the Atlantic Rim groundwater model Technical Report (WWC 2005).

The results of the simulation show that the drawdowns within the coal package (layer 3) are relatively severe as compared to the drawdowns projected within the overlying and underlying sandstone packages (layers 1 and 5, respectively). The maximum drawdown and areal extent of drawdown within the Almond Formation coal (layer 3) is projected to occur in 2030. Drawdown contours projected to occur for layers 3 (coal package), 1 (overlying sandstone package), and 5 (underlying sandstone package), respectively, in year 2030 are depicted in Appendix M. As shown, maximum cumulative drawdowns in the coal are greatest at the production well locations, although drawdowns do not propagate down dip to the west. In fact, no drawdowns in the produced coal are expected to occur beyond the western boundary of the ARPA. Coal drawdowns are projected to propagate somewhat more in the up dip direction toward the Almond Formation's outcrop, although are not expected to actually reach the outcrop.

While the drawdowns within the coal package are relatively severe immediately around the production well locations, the water discharge rate from each well does not decline over time as severely as expected. Table 4-6 presents the average per well discharge rate at the end of each five-year period between 2010 and 2050. Table 4-7 depicts the modeled impacts to the various existing flowing wells within the ARPA, and as shown, impacts to the flowing wells are predicted to be minimal. Impacts to the contact springs are also predicted to be minimal. In year 2005, the modeled spring discharge was approximately 88,800 cubic feet per day for the entire model area. In year 2050, the modeled spring discharge was approximately 85,200 cubic feet per day for the entire model area.

Table 4-6. Average Per Well Discharge Rates Each Five Years During the Simulation Period.

Year	Number of Wells in Production	Average Discharge Per Well (gpm)
2005	48	30.1
2010	989	32.4
2015	1368	34.2
2020	1651	33.7
2025	1720	32.9
2030	1682	32.9
2035	904	34.4
2040	422	33
2045	105	22.9
2050	8	7.8

Table 4-7. Impacts to Flowing Wells in Year 2050.

Latitude	Longitude	Row	Column	Year 2000 Modeled Flow Rate (gpm)	Year 2050 Modeled Flow Rate (gpm)
41.0894	107.4968	114	190	30	27.9
41.0725	107.5053	115	188	28	26
41.0887	107.4782	114	195	2	1.4
41.1985	107.5103	95	186	15	12.9
41.2613	107.5798	84	167	2	1.6
41.6022	107.4658	22	199	3	2.2
41.2263	107.5572	90	173	21	20.4
41.1946	107.5880	96	165	5	3.5
41.1902	107.5675	97	171	5	4.0
41.3024	107.6040	76	161	21	19
41.3240	107.6160	73	157	9	8
41.3493	107.6245	68	155	24	21.4
41.3495	107.5956	68	163	8	7.2
41.3815	107.5660	62	171	9	0*

* A production well was placed in the same cell as the flowing well.

Recovery

After water production starts to decline, recovery of water levels in the coal would become apparent. Based on the projected development of wells, all production is expected to end by 2050. In order to simulate recovery, all drains except for the ones simulating the contact springs were shut off by 2050. The model was then run for an additional 2,950 years to model the long-term effects of groundwater withdrawals. Recovery predictions for years 2100, 2500, and 3000 are included in the Atlantic Rim groundwater model Technical Report (WWC 2005). The model predicts that recovery in the coal would be slow; however, most of the recovery would have occurred by the year 3000.

The model also predicts that it takes a relatively long time for groundwater adjustments within the coal to have an effect on groundwater levels within the Almond sands and Pine Ridge Sandstone. The timing of the maximum impacts to the Almond/Lewis Shale contact springs demonstrates this phenomenon. The most severe impacts to the springs were modeled in the year 3000, at which time the discharge rates start to increase. This recovery scenario assumes a constant recharge based on the recharge rates arrived at empirically during the steady-state calibration. This recharge rate, while arguably the best assumption that can be made, is nevertheless based on limited calibration experience and research information available at this time.

4.4.3.2 Proposed Action Impacts

4.4.3.2.1 Proposed Action Impacts to Surface Waters

As described in Chapter 2, total construction phase surface disturbance resulting from the Proposed Action would be about 17,600 acres (5.7% of the ARPA). The construction disturbance would not be uniformly distributed across the project area, but rather, project facilities would be located where the efficiency and feasibility of extracting the natural gas would be the highest. Combined with the estimated existing disturbance of 600 acres, cumulative disturbance would be about 18,200 acres (5.9% of the ARPA). Impacts to surface water are not directly related to surface disturbance, as described in impacts common to all action alternatives roads and pads can impact surface hydrology beyond their initial disturbance.

The primary roads utilized to access the ARPA are U.S. Interstate Highway 80, State Highway (WY) 789, WY 70 and WY 71. A number of Carbon County and 2-track roads provide access to and within ARPA. Currently, there are approximately 1,000 miles of existing primary, secondary and 2-track roads within the ARPA (about 2.5 mi/mi^2).

With successful reclamation, during the life of the project (30-50 years), total disturbances would be reduced to about 6,200 acres (about 2.0% of the ARPA). As describe earlier most of the ARPA would be difficult to reclaim. Reclamation success in this case would mean an area free of weeds with grass/forb regeneration. Where sagebrush, juniper or other vegetation was disturbed the location would not return to pre-disturbance hydrologic function until 30-50 years after the end of the project in some locations as described in the impacts common to all section.

The construction disturbance associated with the Proposed Action can also be distributed by watershed. As discussed in Chapter 3, the entire ARPA is contained within three major drainage basins. One leg of the Continental Divide runs east and west across the upper portion of the project area. Drainage south of this divide flows south and west to the Little Snake River (Hydrologic Unit Code [HUC] 14050003) in the Colorado River basin. A second leg runs north and divides the northwest and northeast portions of the project area. Drainage west of this divide flows north to Separation Lake in the closed Great Divide Basin (HUC 14040200). Drainage east of the divide flows northeast to the North Platte River (HUC 10180002) in the Missouri River basin. The major drainage basins are depicted on Appendix M: Watershed Basins. The Little Snake River flows east to west just south of the ARPA. Approximately three-quarters of the ARPA drains into the Little Snake River via Muddy Creek. Muddy Creek (HUC 14050004) originates in the Sierra Madre Range, east of the ARPA, and flows west and south to its confluence with the Little Snake River near Baggs. The primary Muddy Creek tributaries in the ARPA include, from upstream to downstream, McKinney Creek, Dry Cow Creek, Cow Creek, Wild Cow Creek, Cherokee Creek, and Deep Creek.

Increasing sediment delivery to watersheds above the 303d section of Muddy Creek (Section 3.4) would lead to habitat degradation in pools and riffles and increase salinity of these waters, resulting in significant effects. The primary watershed contributing to this segment is the Muddy Creek/Alamosa Gulch watershed (Appendix M: HUC Boundaries). The proposed action with 8 wells/section in this watershed would lead to increases in surface runoff and sedimentation into this watershed and would result in significant impacts.

According Chapter 3 the Soils section there are many topsoils that are saline or sodic in the ARPA, these soils when eroded as a result of project activities can make this salt available to surface waters. This would contribute to the non-point source of salt in the Colorado River Basin and can be expected to be a significant impact to this system since these rates would be above background conditions.

Many of the drainage channels in the ARPA are classified as Waters of the United States. Crossings of these channels and any associated wetlands may require authorization from the COE through the CWA Section 404 permitting process. None of the drainages in the Great Divide Basin are considered Waters of the United States and therefore would not need COE permitting. Since, road and pipeline construction across established channels could adversely modify flow hydraulics; required BMPs would protect these channels from long-term changes in hydrologic function (Appendix H). Channel crossings specification in the required BMPs say that crossings would minimize changes in channel geometry and subsequent changes in flow hydraulics and these BMPs require designing channel crossings for a minimum of the 25-year runoff events, or otherwise specified by the BLM. Guidance for designing crossings is given in Appendix J: BMPs for Non-Point Source Pollution, these would be required for drainages with the potential to support fish populations.

As described in Appendix K, water would be required in most aspects of project construction including road construction, drill site construction, well drilling, and pipeline testing. Water for use in the project construction could be as high as 1,000 gallons per acre of disturbance, which would equate to a total of approximately 54 ac-ft of water (for 17,710 acres of disturbance). Water used in the well-drilling process could be as high as 125,400 gallons, or about 0.4 ac-ft of water per well, for a total of approximately 693 ac-ft (for 1,800 wells). Water used in the deeper, conventional well-drilling process averages 462,000 gallons (1.4 ac-ft) per well for a total of approximately 280 ac-ft (for 200 wells). The operators intend to use freshwater-based mud for the majority of their drilling operations. Water would also be used for hydrostatic testing of pipelines. Assuming one set of pipelines per well pad (single or multiple wells), and all pipelines associated with 2,000 well pads (7,920,000 feet of pipeline) would be hydrostatically tested at once and therefore water would not be re-used, approximately 64 ac-ft of water (at 2.6 gal/ft) would be required for hydrostatic testing of pipelines. Therefore, total water demand with hydrostatic testing for the Proposed Action would be approximately 1,100 ac-ft. This total quantity of water would not be withdrawn all at one time; rather, this amount would be distributed over the construction phase that could extend over several years as discussed in Appendix K.

Water used for construction and drilling may not come from CBNG wells, and therefore could possibly come from sources connected to surface waters in the Colorado River Basin. This volume of water is conservatively estimated as 10.3 acre-ft/year for the life of the project. The potential depletions were part of the consultation process with the Fish and Wildlife Service and have been considered in regard with native fish recovery programs in the Colorado River Basin (see Section 4.8 and Appendix G)

Water would be obtained from SEO-approved local surface water sources and/or water wells completed in the coal seams of the Mesaverde Group. As described in Chapter 3, there are presently 90 active permitted groundwater rights filed in the project area, one of which is for a water well that supplies water for drilling deep oil and gas wells. Of the 90 active permitted groundwater rights in the project area, 55 are designated for livestock use. There are approximately 195 surface water right permits within the project area; 165 of the 195 are associated with livestock water facilities. The permitted amounts associated with these water rights total about 43,000 ac-ft per year (42,730 ac-ft are associated with Big Bend Reservoir #1). Roughly 14 percent of the 195 permits are adjudicated. Historically, water wells have been the primary source of supply for oil and gas drilling in this arid area; it is likely that water wells would supply the proposed project drilling needs. The total water demand identified above would not likely adversely affect the existing surface water or groundwater rights in the project area provided full coordination is implemented with the SEO and the BLM. Again, the total water demand of 1,100 ac-ft by the project would be spread out over several years and would not cause significant adverse impacts on the surface water or groundwater resources within the ARPA.

Reclamation would occur on the barrow ditches for roads, portions of well pads, and pipeline ROWs as described in Appendix B: Reclamation Plan. Even after successful reclamation these areas would form distinct vegetation boundaries that may or may not be better for reducing rainsplash erosion or decreasing surface runoff. They also may experience unauthorized travel from off-road vehicles leading to further erosional problems.

Discharge and use of hydrostatic test water, would need to be accomplished in a manner that does not adversely affect soils, stream channels, and surface water and groundwater quality. After testing operations are completed, the water would be pumped into water-hauling trucks and transported to drilling locations within the project area to be used in conjunction with drilling operations or re-used for other aspects of the construction and/or production process. However, if such water is not re-used it must be disposed of in a manner where soil scouring and water quality impairment would not result. Hydrostatic test water is expected to be of relatively good quality; however, it should be evaluated for compliance with State water quality standards. No test water should be discharged unless such water meets these standards. Test water not needed for drilling operations that meets water quality standards would be disposed of onto undisturbed land having vegetative cover or into an established drainage channel in a manner as not to cause accelerated erosion. Further, use and disposal of hydrostatic test water must comply with the mandatory ROW stipulation for hydrostatic testing as well as the POD, the CWA and the WYPDES permit that would be required for the proposed project.

4.4.3.2.2 Proposed Action Impacts to Groundwater

The proposed CBNG development in the ARPA is targeted principally at coal beds contained in the Almond Formation member of the late Cretaceous Mesaverde Group. Drilling depths for the Mesaverde coals would range from approximately 1,200 to 6,000 feet. Groundwater would be removed from the coal seam aquifers. There is no current practical use for water in these coal seams due to drilling and management costs, the high level of TDS concentrations, and the availability of higher quality water from shallower aquifers. The targeted coal seam aquifers that would be dewatered are classified as confined to semi-confined aquifers because they are bound by confining sedimentary layers of shale, siltstone, and claystone that are impervious to semi-pervious. Furthermore, the targeted coal seam aquifers are stratigraphically lower and hydraulically isolated from shallow groundwater sources that are typically developed.

Effects from development of CBNG to groundwater resources within and near the ARPA have been evaluated in the South Baggs Area Natural Gas Development EIS (USDI-BLM 2000), Sun Dog POD EA (USDI-BLM 2001), Blue Sky POD EA (USDI-BLM 2002a), Cow Creek POD EA (USDI-BLM 2002b), Brown Cow POD EA (USDI-BLM 2003a), Doty Mountain POD EA (USDI-BLM 2003b), Red Rim POD EA (USDI-BLM 2003c), Jolly Roger POD EA (USDI-BLM 2004a), and the Rawlins Draft RMP (USDI-BLM 2004b).

Reserve pits would be utilized to contain drilling fluids, cuttings, and wastewater produced from the well drilling operations. In some cases the reserve pit would be lined with an impermeable liner to prevent seepage and possible contamination of surface and groundwater. Leakage of pit fluids would be minimal from lined reserve pits unless the liners were installed incorrectly or the liners were damaged during drilling operations. Thus, adverse impacts from leaks in lined reserve pits would likely not occur.

4.4.3.3 Alternative A – No Action

For both ground and surface waters, impacts would continue as described in the EAs developed for each POD during the interim drilling policy. It can be expected that as interim reclamation success improves that impacts to surface water resources would decrease. Final reclamation would disturb areas again initially, but long term reclamation would reduce impacts to background levels within 5 years after final reclamation.

4.4.3.4 Alternative B

4.4.3.4.1 Surface Waters Impacts for Alternative B

The most beneficial feature of this alternative is that it would give more definition to the development periods. Due to the temporal development, there would be feedback in the form of monitoring to better plan future development in subsequent phases. Individual watersheds would receive more initial disturbance for construction under this alterative, but would also improve the success of interim reclamation. Interim reclamation would be more successful due to economies of scale in terms of planting, treating for weeds, travel planning and other tasks. When these activities occur in only a portion of the project area at a time and we can assume these economies of scale would be realized.

4.4.3.4.2 Groundwater Impacts for Alternative B

The groundwater model results included within the draft EIS assume that development within the ARPA occurs in the northern (phase 1), middle (phase 2) and southern (phase 3) portions of the project area simultaneously. However, it should be noted that within the existing groundwater model, development in the middle portion of the project area generally occurs first followed by development in the northern section and the southern portion of the project area, respectively. The original development scenario assumed that additional development was centered on existing units and propagated concentrically from each unit. The largest units, and most of the existing development, were within the central portion of the ARPA. Therefore, at the beginning of the groundwater flow simulation the bulk of the development was within the central portion and the northern and southern reaches were reached later on within the simulation. Discussions with Anadarko personnel indicated that development within the southern portion of the ARPA would occur last, so development within the southern portion of the project area was limited to development within the existing units until near the end of the simulation period.

Changing the temporal distribution of the development (as proposed in Alternative B) would not result in long-term changes to the groundwater model results (i.e., recovery period and affected contact spring discharge rates.) It would only change the timing of the short-term drawdowns and the drawdowns during production. Changing the spatial distribution of the wells has the potential to change both the shape of the drawdowns and the long-term results. For example, depending on the placement of the wells, the recovery period may be longer or shorter, and the timing and magnitude of the maximum effects on the contact spring may vary. Overall, the model is not appreciably sensitive to spatial and temporal distributions of the wells. It is however, more sensitive to hydraulic conductivity, drain conductance, and the storage coefficient of the aquifers. It would also be very sensitive to the length of time it takes to fully develop each well, which at this time is based on existing production within the ARPA.

4.4.3.5 Alternative C

4.4.3.5.1 Surface Waters Impacts for Alternative C

There are a number of development protection measures that have been developed to reduce impacts to resources for alternative C. These development protection measures are designed to reduce sediment loads to channels and changes in peak flows from surface runoff and intercepted groundwater by reducing disturbance, improve reclamation success, and reduce impacts to visual resources, vegetation and wildlife. The following development protection measures would be implemented under this altenative:

1. Pump reserve pit and do earth work for reclamation right after drilling, put in top soil and plant first good season, interim reclamation would be completed one year after spud date.
    - Reduces erosion from pad sited since it severely cuts the amount of time the pad is unvegetated, and therefore more susceptible to erosion.
    - Reduces erosion from spoils and topsoil piles.
    - Improves infiltration on the site by reducing the amount of compaction from vehicles in the interim reclamation portions of the pad.
    - Improves the success of interim reclamation since the topsoil would still be biologically active.
    - Reduces the likelihood of contamination of shallow groundwater by reducing unauthorized dumping in the pit and also the use of the reserve pit for flow back of fracing fluids, since the pit would be open less of the time.

2. No pad, compressor or water transfer sites can be located in these areas. – This would not allow well pad or other facility placement in these areas identified with special resource concern, but would still allow for utilities, roads and other linear features with engineering designs when the area cannot be avoided.

3. Road density criteria – For the most part this would limit collector and local roads to existing two-tracks and would likely be combined with item 7, low impact road designs and would require optimal road network designs.
    - Where roads have been identified as the major impact of gas development, this impact would be reduced.

4. Specifying a maximum surface disturbance criterion.
    - Reduce well pad density
    - Allow for better placement of roads to reduce impacts to surface hydrology.

5. Pitless, shared pit and/or closed system drilling - Instead of using a reserve pit to flow back fluids during drilling, a tank would be used. A small pit would still be needed for the drilling cuttings and could be shared among wells, but the pit would be approximately ½ the size and would not need to be as deep.
- o This would reduce the footprint of the pads on average to about ½ the size
- o This would reduce the risk of groundwater contamination since most fluids would be contained in tanks instead of the reserve pit.

6. Low impact road design – This technique would use brush beating, the placement of matting, fabric or whatever is suitable and placement of at least 6 inches of engineered road base (i.e. mostly gravel/sand with minimal tackifier). This technique would not be used when a sideslope of greater than 3% is needed for the road design, conventional construction would be used in these areas (see Appendix J: BMPs for non-point source pollution). Any blading or the construction of ditches would be minimized and only occur when slope is greater than 8% or when needed for cross drainage. For some areas only resource roads (the portion of roads that go directly to an individual well pad) would require this and this technique would also be used for only the portion of the pad site that needs regular vehicular traffic for well maintenance. This method would require ditch witching for all utilities and placement in the travelway of the road when terrain would require the right of way to be bladed to install utilities.
- o With the elevated roadway there would generally not be a need for drainage ditches
- o Significantly reduces surface disturbance.
- o Less need for intense interim reclamation with earthwork, native regeneration would be more than sufficient in areas that have been brush beat and have received temporary disturbance from tank placement, ditchwitching or limited vehicular travel.
- o Reduce areas impacted by soil compaction, by leaving underlying soils intact. This would improve infiltration and reduce surface runoff.
- o Would significantly improve success of brush regeneration, and native forb success. These would reduce erosion from rainsplash and improve surface roughness and hence reduce surface runoff, riling and other hillslope erosional processes.

7. On collector and local roads, new construction would require 95% compaction before gravel is added. All existing roads would need coordination with County and BLM to improve surface. All collector and local roads, would annually receive a non-chlorine based dust abatement chemical treatment to reduce dust.

8. Best management practices such as waddles at the input and output of culverts, erosion fabric/matting on steep cut and fill slope, placement of sediment fences during construction etc.
- o All these activities would improve reclamation success and reduce impacts to surface hydrology.
- o Overall implementation would reduce impacts when areas such as soils with high-runoff potential are identified ahead of time.

4.4.3.5.2 Groundwater Impacts for Alternative C

There should not be a significant difference between this alternative and the proposed action for groundwater resources.

4.4.4 Impacts Summary for all Alternatives

Impacts resulting from drill pad, access road, facility site, and pipeline ROW construction could include removal of vegetation, exposure of the soil, mixing of soil horizons, soil compaction, loss

of topsoil productivity, and increased susceptibility of the soil to wind and water erosion. These impacts could increase runoff, erosion, and off-site sedimentation.

Due to extremely low hydraulic conductivity of the confining layers, enhanced leakage from any aquifer stratigraphically above or below the dewatered coal seams would be minimal, and only after a period of time would drawdown effects in any overlying aquifer become apparent.

A predicted total project volume of produced water in the best success scenario for 2,000 well development would be 250,000 to 450,000 bbls/day for approximately 6 to 8 years. This produced water would be disposed of through 83 injection wells completed in the Hatfield, Cherokee or Deep Creek sands within the Mesaverde Group. The water would be injected into these wells for the life of the project. No cumulative impacts to the target members of the Mesaverde Group would occur during this project.

4.4.5 Mitigation Summary

The Required BMPs (Appendix H) and applicant committed measures (Appendix K) measures and procedures would be followed under all alternatives and are critical to reducing impacts to water resources.

The Required BMPs (Appendix H) would be followed on BLM lands or where a BLM approved action would impact BLM lands. A modification to a mitigation measure and/or design feature may be approved on a case-by-case basis when deemed appropriate by the BLM. An exception would be approved only after a thorough, site-specific analysis determined that the resource or land use for which the measure was put in place is not present or would not be significantly impacted. Many of the measures below are designed to reduce the impacts experienced during the interim drilling period as described in section 3.4.5.3 "Current POD Conditions". The benefits of each of these BMPs are briefly described below:

- <u>Water management plan as part of the annual work plan submittal in April</u> – This would provide detailed information on current water disposal needs and injection capacity.

- <u>Surface disturbance on slopes >25% as identified from the 30 meter DEM data</u> – The Digital Elevation Model (DEM) slope data is areas with steep topography in general, these areas should be avoided for construction activities.

- <u>Drainage Crossings</u> – These would be designed for at the minimum for the 25 year storm event and in such a way to not modify the drainage hydrology. These measures as well as the drainage design criteria for drainages with potential fish habitat in Appendix J would protect most crossings from direct impacts.

- <u>Mitigation to Reduce Surface Runoff and Erosion</u> – The annual Work Plan would describe the location and types of mitigation as described in Appendix H. This would allow for the evaluation during onsites and a final construction plan would then be submitted that would include locations of mitigation measures.

- <u>Well Inventories and Water Developments Associated with Groundwater</u> – Although the groundwater model predicted only reductions in wells used for water development, should wells be impacted by project actions a well agreement would be sought by the operator to mitigate impacts.

- Interim Reclamation of Unused Areas – Proper reclamation of the interim surface disturbance is essential for minimizing impacts from erosion and weed propagation. The Reclamation Plan (Appendix B) would require the operators to submit annual reclamation plans that would include progress. This accountability should help improve current reclamation practices.

- Water Used for Construction, Maintenance, and Drilling Activities – All waters, subject to approval by the Wyoming SEO, for these uses would come from the Colorado River or Great Divide Basins and most of the water would come from CBNG wells. This would remove the potential for impacts in the North Platte River System and reduce impacts to surface water uses.

Applicant committed measures would be applied on privately owned surface and State of Wyoming lands unless otherwise specified by the involved private and/or State surface owners. The Operators and the BLM, as discussed in Chapter 2 and Appendix K, would implement preconstruction planning and design measures described.

4.4.6 Residual Impacts

Significant impacts to surface hydrology would occur under the proposed alternative and Alternative B (Temporal Alternative). These impact including negatively impacting a waterbody (Muddy Creek West of 789) listed on the State 303d list, changing streamflow characteristics in stream channels, alteration of stream geometry and increasing sediment to the point of degrading a streams designated use (Muddy Creek, from the eastern project boundary to the confluence with the Little Snake. No significant impacts are expected to occur under Alternative A (No Action) or Alternative C (Spatial Alternative).

4.5 VEGETATION AND WETLANDS

4.5.1 Introduction

Direct impacts to existing native shrub/grassland communities in the ARPA resulting from project implementation include a short-term reduction of herbaceous vegetation and a long-term loss of shrub cover. Potential indirect impacts to the vegetation resource may occur as a result of damage to biological soil crusts, soil compaction, mixing of soil horizons, loss of topsoil productivity, increased soil surface exposure, soil loss due to wind and water erosion, increased potential for noxious/invasive weed invasion and establishment, shifts in use patterns or amounts by livestock and wildlife, and changes in visual aesthetics.

4.5.2 Impact Significance Criteria

Several criteria were used to determine the significance of impacts caused by the construction and operation of the proposed natural gas project on vegetation resources encompassed within the ARPA. These criteria were developed based on federal, state, and local agency rules, regulations, and management guidelines.

The impact on vegetation would be considered potentially significant if the following were to occur:

- non-attainment of short- or long-term reclamation standards and goals for disturbed sites specified by the Reclamation Plan (Appendix B) or the BLM resulting in a loss/decrease of plant species density, diversity, and abundance, or where reclaimed areas do not attain adequate vegetation groundcover and species composition to stabilize the site within five years from disturbance;

- an event or action that would remove a community's unique attributes or ability to support other resource values within the life of the project;

- introduction or spread of noxious or invasive weeds that contributes to unsuccessful revegetation, the introduction of weeds into areas considered weed free, or an increase in noxious or invasive species where they already exist.

- Wyoming BLM Standards for Healthy Rangelands are not met.

4.5.3 Direct and Indirect Impacts

4.5.3.1 Direct and Indirect Impacts Common to All Alternatives

Direct impacts include the removal of native vegetation and topsoil during the construction phase and installation of permanent structures (e.g., compressor sites, roads, and well pads). Future climatic patterns, land use, and compliance with the Reclamation Plan and weed control efforts would be primary factors for successful LOP reclamation. Monitoring sites for documenting long-term trend of vegetation cover types would be avoided so that disturbance from permitted commercial activities would not occur.

Potential indirect impacts to the vegetation resource may occur as a result of soil compaction, mixing of soil horizons, loss of topsoil productivity, increased soil surface exposure causing increased soil loss due to wind and water erosion, and increased potential for noxious/invasive plant establishment. Additional indirect impacts occur as a result of altered runoff hydrology due to roads, pads and other facilities, particularly on moderate to steep slopes. Slopes greater than eight percent require special engineering and are found on 35 percent of the project area. Facilities located in these areas reduce natural runoff to downslope locations and increase channelization of flows and gullying, which results in desertification effects including lower productivity, cover and species composition downslope. Another indirect effect is dust from roads, which settles on nearby vegetation and results in reduced photosynthetic activity and plant growth.

All alternatives would disturb Wyoming big sagebrush and alkali sagebrush plant communities. Due to the very long to unknown recovery rates for these two shrub species on dry, harsh sites, reclamation would primarily result in herbaceous plant recovery, replacing shrublands with grassland-type cover and structure.

The saltbush steppe vegetation cover type would have very low acreage affected by the proposed action. Badlands have sparse vegetation, occur on moderate to steep slopes, and are common in other areas. Therefore, impacts from disturbance to these vegetation cover types would not affect their overall abundance, health or diversity across the region.

Thirty-one percent of the aspen, juniper woodland, serviceberry, and true mountain mahogany cover types occur on private and state lands. These sites would not be protected from

disturbance by any development. Loss of these communities would increase wildlife use on remaining areas within these cover types and exacerbate current declining health conditions.

Due to the scarcity of wetland/riparian sites in the ARPA and BMPs/COAs to protect them, the probability of well pads, roads, pipelines, and ancillary facilities being placed in these areas is very low. The RMP specifies that a 500-foot (minimum) buffer around riparian and other water resources and a 100-foot buffer from ephemeral drainages be maintained. This restriction not only protects wetland/riparian sites, but basin big sagebrush sites which are generally found adjacent to drainages. Additionally, permits under Section 404 of the Clean Water Act would be required for any activities in wetlands or waters of the United States. The Operators would be required to demonstrate to the COE that there are no "practical alternatives" to placement of a well location in a wetland. The probability of removing wetland vegetation or disturbing any waters of the U.S. is low following compliance with mitigation procedures. Existing water sources that dry up or have reduced flows due to water draw-down associated with gas field development would be mitigated to maintain wetlands/riparian site characteristics and vegetation.

Although most natural gas would be collected as water is removed from the coal aquifers, some gases would move upslope through the formation and escape through the soil surface. Where this occurs the vegetation would die back, resulting in dominance of herbaceous species and increased bare ground. These locations would generally be small and scattered along the outcrops of the coal formations, probably affecting less than ten acres altogether.

Vegetation treatments would become more complex and costly as the density of field development increases. The opportunities to utilize prescribed burns as a management tool would become more limited, requiring increased use of chemical and mechanical forms of manipulation. These methods decrease the ratio of shrub versus herbaceous species, but primarily influence species already present, compared to fire which creates openings for early succession species (especially forbs). Therefore, in areas where the objective is to increase forb composition and there are currently few forb species present in the community, it would be difficult and more expensive to reach this objective using chemical or mechanical forms of treatment.

Direct and indirect impacts to the vegetation resource would be reduced with implementation of and compliance with Required Best Management Practices stated in Appendix H, Applicant Voluntarily Committed Measures (Appendix K), the Reclamation Plan (Appendix B), and the RMP. However, no measures currently address spreading concentrated runoff back over the land. Therefore, channelization and gullying leading to desertification would occur. Achieving final reclamation goals is dependant upon disturbed soil properties, developing seed sources for native forbs and shrubs, short- and long-term monitoring, future climatic conditions and land-use patterns, and most importantly, operator commitment. In addition, non-native species used in reclamation on State and private lands could expand onto adjacent public lands, requiring some form of both monitoring and control.

The lack of adequate weed control efforts in the first few years of development under the Interim Drilling Plan has already increased weeds and seed banks that would have to be controlled for several years at a minimum. Halogeton has been observed spreading outside areas of disturbance from CBNG development on all land ownerships. There are no applicant voluntarily committed measures to control weeds; therefore the current trend of weed spread is likely to continue on private and state lands. These populations would continue to pose a threat of expansion onto public lands that would require long-term treatments.

Reinjecting all water produced from CBNG development has both positive and negative impacts upon riparian/wetland plant communities, depending on water quality and how and where water releases occurred. Obviously, if produced water was higher in salts or other contaminants than natural background levels, reinjection would be a benefit to these communities by not increasing salt loading that would shift composition to more salt tolerant species and would result in fewer species, less cover, and lower palatability for grazers and browsers. Water would not be released down ephemeral draws. This would remove the potential for headcutting and increased sedimentation downstream into existing riparian plant communities. Water would also not be released down perennial stream channels at high rates year around which would result in widening or blowing out the vegetation and channel characteristics. Water releases down perennial channels that mimicked natural flow patterns (high in spring or other short peaks in runoff and reduced the rest of the year) would not be allowed. However, there would not be benefits to riparian/wetland habitats from artificially maintaining moisture levels during dry years if water produced was equal to or of better quality than natural runoff. Species requiring higher moisture levels like sedges, bulrushes and willows would not be supported during dry years. This results in existing natural conditions of lower productivity, lower bank cover, and transition to drier tolerant species with lower bank holding capability, greater erosion, and reduced structural diversity being maintained. The opportunity to artificially maintain or enhance riparian habitat along streams in general would not occur; including maintaining sufficient flows down Separation Creek to maintain the 800 acres of riparian/wetland habitat in Mahoney Lakes, resulting in the continued loss of this habitat until climate patterns change.

4.5.3.2 Proposed Action

The proposed action assumes drilling of approximately 2,000 new natural gas wells and construction of required ancillary facilities over the next 20 years. This would directly reduce the extent of existing vegetation cover types. Over the estimated 20-year development phase, the Proposed Action is projected to initially disturb an estimated total of 15,800 surface acres which represents about 6% of the total land surface of the project area (270,000 acres). Also, half of this disturbance would occur within the first six years. During the projected 30-50 year life-of-project (LOP), the disturbed acres would be reduced to about 6,200 acres depending upon time required for successful reclamation, future land uses and climatic conditions. This would hold true for reclamation of herbaceous species, but not for shrubs habitats to be returned to pre-existing conditions. Indirect impacts due to dust from roads is expected to affect vegetation adjacent to roads, resulting in an additional 15 to 30% of the development area and 5-10% of the natural gas development area (based on estimate of 300 feet width impacted along roads).

Direct and indirect impacts to vegetation would affect specific plant communities to varying degrees depending on general abundance, browse use, topography, and difficulty of reclamation. The majority of development would occur in mountain and Wyoming big sagebrush vegetation cover types, since they occupy about 85 percent of the ARPA. However, long-term impacts to Wyoming big sagebrush would be much higher than to mountain big sagebrush.

Wyoming big sagebrush plant communities occur on sites with lower precipitation and poorer soils, which increases the difficulty in reclamation and the likelihood that only initial shrub reestablishment may occupy disturbed sites during the estimated 30-50 year LOP. This loss of shrub habitat from direct disturbance, coupled with dust drifting off roads making nearby vegetation less usable, would equate to a 20 to 35 percent reduction in available Wyoming big sagebrush habitat. Even though the majority of disturbance would not be in antelope and mule deer CWR, it would be in adjacent transition range. With average browse rates on crucial winter

range (CWR) and adjacent transition range already at moderate levels (40 to 60 percent) during average winters and higher during severe winters; this reduction in usable habitat would lead to increased browse use levels that would result in plant mortality.

For the most part, impacts described in this and sections below are primarily about CBNG wells, since the actual number and location of deep natural gas wells is speculative at this point. However, development of deep natural gas wells in the Wyoming big sagebrush plant community would have the greatest negative impacts (versus other plant communities), because they would be compounding the negative impacts already described for CBNG development. In addition, approximately eight percent of this cover type occurs on moderate to steep slopes that would be affected by increased gully erosion and desertification due to the influence of roads on overland hydrology.

In allotments where grazing reductions or suspension of use is made by the livestock permittee due to the rate and scale of field development, there would be affects to the vegetative resource. Plant material previously removed or trampled by livestock would be left largely ungrazed, resulting in increased litter, soil protection, and reduced runoff and erosion. Plant vigor may improve in some areas, but most allotments with rotational grazing already have good vigor of desired species. Reclamation efforts would benefit without being grazed by livestock. However, grasses would eventually out-compete forbs and shrubs in the absence of livestock grazing. In Wyoming big sagebrush transition and crucial winter range, increased grass cover and vigor may, in combination with increased shrub browsing, reduce establishment of shrub seedlings. This would skew the age-class ratio and contribute to the long-term decline in Wyoming big sagebrush cover and density. Therefore, impacts from disturbance to this vegetation cover type would affect its abundance, health and diversity across the region, exceeding the significance criteria.

Mountain big sagebrush sites occur in areas with higher precipitation and better soils, and should reclaim more easily than Wyoming big sagebrush sites. Whether these sites would return to pre-existing levels of sagebrush cover during the 30-50 year LOP is unknown. Following prescribed burns in this area, mountain big sagebrush has been documented recovering to original cover levels in 40 to 50 years. In field development, soil profiles and structure is altered, which would likely lengthen time needed for recovery of shrubs. The elevation this species occurs at also precludes it from receiving more than light browsing by big game species before it is protected by winter snow. Approximately one-fourth of this type occurs on moderate to steep slopes, particularly in the vicinity of the Muddy Creek drainage, Muddy Mountain, and the Deep Gulch/Wild Cow area. These sites would be affected by increased gully erosion and desertification due to the influence of roads on overland hydrology. Therefore, impacts from disturbance to this vegetation cover type would affect its health and diversity on locations with moderate to steep slopes, exceeding the significance criteria in these areas. However, acreage loss from disturbance would not affect its' overall abundance, health or diversity across the project area.

Alkali sagebrush is the third most common vegetation cover type within the ARPA, but is not common within this region or even within the State of Wyoming. The high clay content in the soils it grows upon has high runoff and severe water erosion potential once the protection of vegetation cover is removed, and increases the difficulty of reclamation. Dust would also be an issue from these sites due to the fine soil particles that would settle on plants and further reduce the availability of usable forage. Although this species receives some browse use by wildlife and sheep, the use levels do not approach those documented for Wyoming big sagebrush. However, with 20 to 35 percent of usable forage lost to disturbance or unavailable due to dust,

the use levels may increase to become a concern. Therefore, impacts from disturbance to this vegetation cover type would reduce its' overall abundance, and may affect its' health and diversity across the region, exceeding the significance criteria.

Mountain big sagebrush/mountain shrub mix vegetation cover types occur on sandier sites around the sandhills and on steeper, north and east slopes where snow drifts and provides higher precipitation levels. The steeper slope sites would be avoided, so loss from project disturbance should be minimal. Sites around the sandhills contain high amounts of bitterbrush which is important to mule deer during the fall and winter and is not abundant elsewhere in the ARPA. Bitterbrush should be able to be reestablished on these sites, but not within the LOP; therefore, impacts from disturbance to this vegetation cover type would affect its health and diversity in localized areas. However, acreage loss from disturbance would not affect its' overall abundance, health or diversity across the project area.

Juniper woodland and true mountain mahogany vegetation cover types occur on gentle to steep slopes, often on poorer, shallower soils over rock substrate. The aspen and serviceberry cover types are found on good soils and higher elevation sites that drift in with snow. These types are not abundant within the ARPA, but are much more common in other areas of the RFO. Since these habitat types failed Rangeland Health Standard #3 –Upland Plant Health in the Upper Colorado River Basin watershed assessment (2002), additional disturbance of these habitats would be counter to ongoing efforts to improve their health. Although sites on moderate to steep slopes would likely be avoided due to increased construction difficulty, there currently are no protective measures for these communities. Therefore there could be a negative effect on the local abundance, health and diversity, exceeding the significance criteria, although not on a regional basis.

The silver sagebrush/bitterbrush vegetation cover type occupies sand dunes in what is known as the "sandhills". The uniqueness of this vegetation/soils complex within the entire State of Wyoming led to the designation of "Area of Critical Environmental Concern" (ACEC). The actual ACEC is mostly excluded from the ARPA, but the north end of this unique plant community is in the checkerboard land pattern and a portion is included in the ARPA. The sand dunes, whether stabilized or not, are usually avoided due to the difficulties they pose for development and reclamation. The potential to increase wind erosion and destabilize the loose sand is very high. Therefore, impacts from disturbance to this vegetation cover type may affect its' overall abundance, health and diversity within the region, exceeding the significance criteria.

The ability to reestablish native vegetation on sensitive soil types (i.e., clayey, sands, saline-sodic) is not well documented in this area, but may be in other locations. Although current technology exists to stabilize these areas and minimize soil erosion as revegetation is being carried out, there is currently a lack of local seed sources for native forb and shrub species, and the recovery rate to restore native shrubs (particularly Wyoming big sagebrush and alkali sagebrush) to their pre-existing condition is unknown. This would likely lead to a two-phased reclamation, initially grasses with weed control and 3-5 years later interseed grasses with forbs and shrubs when native seed is available. Many of the potential impacts to the vegetation resource would be reduced assuming construction, maintenance and operation of well pad sites and associated disturbances are in accordance with Chapter 2 of this EIS, the Reclamation Plan, the BMP/COA appendix, and RMP stipulations.

Surface disturbing activities would increase the potential for new infestation and spread of existing invasive plant species populations. Invasive weed species usually thrive on newly disturbed surfaces and out-compete more desirable native plant species. On the other hand,

prompt and successful reclamation would reduce the potential for these species to establish and spread. Assuming that existing weed populations on public lands would receive adequate treatments in the future, potential weed expansion onto public lands would not occur; therefore weeds would not exceed the significance criteria.

4.5.3.3 Alternative A - No Action

Under the No Action Alternative, direct and indirect vegetation impacts would continue under the interim drilling plan. The lack of adequate weed control efforts in the first few years of development under the Interim Drilling Plan has already increased seed sources for weeds that would have to be controlled for several years at a minimum. Halogeton has been observed spreading outside areas of disturbance from CBNG development. If the current trend is continued, there would be an introduction of weeds into areas considered weed free, and an increase in noxious or invasive species where they already exist, which would exceed the significance criteria.

4.5.3.4 Alternative B

Alternative B is the same as the Proposed Action in terms of number of wells drilled, acres disturbed both short-term and long-term. The principle difference is that the majority of disturbance would occur in phases, still with half the disturbance/development occurring within the first six years. In terms of impacts to vegetation cover types, they would essentially remain the same as described under the Proposed Action.

There may be some benefits to vegetation related to the concentrated development. This method of developing all wells, roads, pipelines and facilities at the same time may result in better planning and reduced acreage of disturbance to vegetation. It would also provide additional time to: develop native plant seed sources, determine successful reclamation techniques for clay soils with alkali sagebrush, and complete drilling and knowledge learned from the Interim Drilling Plan that may reduce impacts to juniper woodland and true mountain mahogany/mountain shrub communities in the southern portion of the ARPA.

This alternative would increase the likelihood of suspension of all grazing use by the livestock permittee due to the rate and scale of field development, with affects to the vegetative resource similar to the proposed action. The principle difference would be in reclamation, as there would be no need for fencing of pads and other facilities to protect them from grazing until vegetation was sufficiently reestablished. Livestock grazing would not hinder reclamation success which would further reduce the potential for weed establishment. Weeds would not exceed the significance criteria.

4.5.3.5 Alternative C

Alternative C would proceed with development similar to the Proposed Action, but would limit the acres of disturbance or recommend avoidance to protect sensitive values. Examples of sensitive values are areas with steep slopes, soils with high runoff potential, big game crucial winter range, and juniper/mountain shrub plant communities. Since about 95 percent of the ARPA is affected by one or more restrictions for sensitive values (Appendix M: Alternative C--Resources with limited surface disturbance mitigation measures), the total acres disturbed would be reduced by about 64%, with impacts in different plant communities affected to varying degrees.

For instance, alkali sagebrush grows on clay soils with a high runoff potential, so this community would have less than half the disturbance than a comparable site supporting Wyoming big sagebrush. However, sagebrush sites within two miles of active leks that qualify as nesting habitat would also have limited disturbance. In addition, locations on moderate to steep slopes would have reduced surface disturbance compared to sites on gentle slopes; this would further reduce desertification impacts caused by alterations to runoff hydrology from roads. These benefits would affect all plant communities on moderate to steep slopes. Juniper woodland, aspen, serviceberry and true mountain mahogany communities would be avoided, which would maintain the current acreage of these types on public land in the ARPA.

The additional mitigation measures would result in less acreage being disturbed, but some shrub species (Wyoming big sagebrush, Alkali sagebrush, silver sagebrush/bitterbrush) still would not be replaced, removing the community's unique attributes or ability to support other resource values within the LOP, thereby exceeding the significance criteria.

This alternative would continue the likelihood of suspension of all grazing use by the livestock permittee due to the rate and scale of field development, but on a pasture or regional scale within allotments. Within these smaller development areas, the principle difference would be in reclamation success, as there would be no need for fencing of pads and other facilities to protect them from grazing until vegetation was sufficiently reestablished. Livestock grazing would not hinder reclamation success which would further reduce the potential for weed establishment. Weeds would not exceed the significance criteria.

4.5.4 Impacts Summary

Impacts from the Proposed Action would include direct removal of acreage of vegetation communities, and indirect loss of usability from dust, thus decreasing abundance and redistributing use of these native species throughout the LOP (or longer). Disturbance in aspen, juniper woodland, mountain shrub, and Wyoming big sagebrush communities within mule deer and antelope transitional and crucial winter range, would also require long-term recovery and may exacerbate existing management issues that led to the failure of Rangeland Health Standards #3 (Upland Vegetation) and #4 (Wildlife Habitat).. Sites located in the mountain big sagebrush cover type would recover with reclamation. In addition, the desertification of rangelands due to changes in overland hydrology on moderate and steep slopes would negatively affect more than one-third of the ARPA. Project implementation would potentially reduce the amount and functions of wetlands, special aquatic sites, and other waters of the U.S due to accelerated erosion and sedimentation from adjacent moderate and steep slopes. Development of additional seed sources for native forbs and shrubs to use in reclamation would not be required; therefore only limited or region-specific seed sources would be available for reclamation. Disturbance to most vegetation cover types would exceed the significance criteria and weed presence would not exceed significance criteria.

Impacts for Alternative A would include disturbed land and associated loss of vegetation as described in the Interim Drilling Plan and associated POD EAs, which would not exceed the significance criteria for vegetation in general. However, the increase in presence and spread of weeds does exceed the significance criteria.

Impacts for Alternative B would be the same as the Proposed Action, with disturbance of most vegetation communities and weed expansion exceeding the significance criteria. If livestock use is suspended, there would be improved reclamation as there would be no need for fencing of disturbed areas to protect them from livestock grazing until vegetation was sufficiently

reestablished. Disturbance to most vegetation cover types would still exceed the significance criteria and weed presence would not exceed significance criteria.

Impacts for Alternative C would promote developing seed sources for native forbs and shrubs to be used in reclamation which would aid in achieving long-term objectives. Avoidance of disturbance in aspen, juniper woodland, true mountain mahogany, and serviceberry communities would protect 69% of these cover types, however disturbance could still occur on private and state lands, contributing to their continuing decline in health. The additional mitigation measures would result in less acreage being disturbed, but some shrub species (Wyoming big sagebrush, Alkali sagebrush, silver sagebrush/bitterbrush) still would not be replaced, removing the community's unique attributes or ability to support other resource values within the LOP, thereby exceeding the significance criteria. Weed presence would not exceed the significance criteria.

4.5.5 Additional Mitigation Measures

There would be no additional mitigation measures for the Proposed Action, Alternative A, or Alternative B.

Additional mitigation measures for Alternative C:

- Restricting surface disturbance to less than 20 acres and four pad locations per section on slopes over 8%
- Avoid surface disturbance within juniper woodland, aspen, true mountain mahogany, and serviceberry communities.
- Promote development of commercial seed sources for native forbs and shrubs

4.5.6 Residual Impacts

Residual impacts would be the same as those described under the impact summary for the Proposed Action, Alternative A, and Alternative B.

Residual impacts from Alternative C include reduced acreage affected by dust, sand blowouts, desertification and accelerated erosion. Long-term loss of Wyoming big sagebrush habitat may not occur with application of mitigation measures. Collection of seeds of native forbs and shrubs to assist federal plant material centers or private producers to develop commercial seeds sources for use in reclamation would help meet long-term objectives of restoring diverse native plant communities following disturbance from permitted activities.

4.6 RANGELAND RESOURCES

4.6.1 Introduction

Impacts to rangeland resources would result with implementation of the Project. Potential impacts would occur throughout the life of the project, from: vegetation and soil disturbance associated with construction activities, reclamation, weed control, road construction and use (i.e. dust and animal collisions), rangeland improvements function, water management, and increased recreational use by the public.

4.6.2 Impact Significance Criteria

Impacts to rangeland resources would be potentially significant if;

- Resource management actions result in >10% permanent reduction in AUMs available for livestock grazing in a given allotment.
- Resource management actions reduce or eliminate the opportunity to run the livestock of choice.
- Wyoming BLM Standards for Healthy Rangelands are not met.
- Vegetation significance criteria are not met.

4.6.3 Direct and Indirect Impacts

4.6.3.1 Direct and Indirect Impacts Common to All Alternatives

The ARPA includes lands that are located within 31 grazing allotments (Chapter 3). In many cases, the boundaries of these allotments extend beyond the boundaries of the ARPA; therefore, discussion of impacts would focus on the 20 allotments primarily affected. The remaining 11 allotments would have similar impacts, but very minor in scale. Under the Proposed Action and all alternatives, cattle and sheep grazing would continue throughout the duration of the project.

Livestock management concerns include reclamation, rangeland improvement functionality, dust from roads, and livestock losses. Adequate reclamation and weed control has been slow in being implemented. Control of halogeton in 2004 was inadequate, forcing one operation trailing sheep to go miles out of their normal trail route to avoid this poisonous plant. Weed control and prompt reclamation occurred on some locations during 2005.

The primary impact to grazing resources would be short-term loss of available forage as a result of construction and production-related disturbance. Available forage would be reduced during drilling and field development and reclaimed as soon as feasible under direction of the Reclamation Plan (Appendix B) and BLM. A long term loss of forage would occur by construction of roads, drill pads, and ancillary facilities that remain permanent during the LOP. Additional forage would not be usable due to dust from roads settling on adjacent vegetation reducing the palatability. The Project would result in increased traffic and increased speeds on the improved roads within the ARPA, particularly during the drilling and field development phase. The potential exists for increased death loss of young livestock due to vehicle collisions following construction of new and higher speed roads. Speed limits should be established and posted as the county has already done on the twenty-mile road south of Rawlins. This would result in decreased potential for livestock/vehicle collisions. There is also the potential for reduced water yield from artesian wells used by livestock as water draw-down in the coalbeds occurs. If this does occur, mitigation would consist of either coalbed methane water of similar quality being substituted to replace the same volume of water no longer flowing, or creating an alternate water source.

The graveled roads reduce dust in the short term, but the scoria commonly used breaks down quicker than other gravels and, in the long term, fugitive scoria dust covers the vegetation resulting in lower palatability and shifting of grazing to other locations. This may reduce usable forage by 15 to 30%, leading to more concentrated use in dust-free locations, leading to lower plant productivity and cover. Increased dust may also affect animal health. These impacts

could include reduced weight gains or require lowering stocking rates in affected allotments. Roads on moderate to steep slopes that result in long-term changes in overland hydrology and desertification impacts below these locations would also lead to lower weight gains or require reduced stocking rates. New and improved access roads would improve livestock operations by improving access for viewing the allotment, facilities and animals; to doctor sick animals; and for trucking animals in or out of an allotment.

The potential exists for disruptions to livestock management actions. There is also potential for damage range improvements from the movement of heavy trucks, drilling equipment, and heavy construction equipment. The mineral companies should promote a policy to report and correct damage to range improvements and livestock facilities as quickly as possible, including contacting the permittee or the BLM. Traffic along roads that pass through shipping pastures or by corrals when in use may interrupt or complicate this work, extending the time and increasing the cost to complete it. Herding of animals through areas being developed or moving around them would increase the complexity and time to accomplish these tasks. In some allotments, management flexibility may be sacrificed to avoid or to minimize these types of impacts. Cattleguards and gates are often damaged by drill rigs that are too wide/heavy, leading to added maintenance and unwanted mixing of livestock. On the west side of Highway 789, there have been numerous instances of gates being left open or fences cut for pipelines that have not been closed or repaired adequately. This has led to mixing of livestock and additional time for herding. In large allotments, this may involve up to a week of additional time.

Disturbance of soils and increased vehicle activity would increase the potential for introduction, establishment, and spread of undesirable non-native/noxious weedy species. This can reduce forage availability and animal weight gains, in addition to affecting trail routes and animal health, particularly increasing death loss of sheep. Recently observed expansion of halogeton from disturbed sites into adjacent native rangelands must also be monitored and treated. Prompt reclamation of disturbed sites and treatment of weeds would minimize the impact of weeds upon livestock operations.

Water resources could be both positively and negatively affected by the proposed action. New water locations may be established in self-contained systems, similar to two water troughs and tanks already authorized on lands of Weber Ranch in the Doty Mountain allotment. These help improve distribution of use and provide water otherwise not available in dry years. Storage tanks and pipelines may be supplemented with water from CBNG development that may save in pumping costs during the LOP. Existing water sources that dry up or have reduced flows due to water draw-down associated with gas field development may affect livestock operations.

4.6.3.2 Proposed Action

The Proposed Action would result in an estimated initial disturbance of about 15,800 acres. This represents about 3% of the total land area of the 31 grazing allotments used by fourteen livestock operators. Initial reclamation would replace forage removed from short-term disturbances. Reclamation efforts would be focused on site stability, with reclaimed vegetation consisting of herbaceous (grass and forb) species. Cattle AUMs total 91% of livestock AUMs. During the LOP, this disturbance would be reduced to about 6,240 acres, or about 1% of the combined land area of the allotments. The amount of forage removed as a result of the proposed action is less than normal variations in forage available from year to year. Therefore, the loss of forage, would be minimal in the short-term and may actually increase available forage in the long-term, and therefore benefit livestock operations.

Impacts would not exceed the significance criteria.

4.6.3.3 Alternative A - No Action

As explained in Chapter 2, the No Action Alternative would allow the Operators to only complete development of wells (200 maximum) already approved under the Interim Drilling Plan. This affects the Doty Mountain, Cherokee, Fillmore and Sixteen Mile allotments, listed in order by the number of wells in each (high to low). Due to this low number of wells, spread across four allotments in excess of 272,000 acres, there would be minimal forage lost or reduced in usability due to dust. This impact should be replaced by forage returning due to reclamation of short-term disturbances, as long as adherences to reclamation and weed control stipulations occur.

Impacts of greater concern are those relating to death loss from vehicle collisions or poisonous plants and disruption of livestock management actions such as vehicular traffic through shipping pastures or altering sheep trailing routes to avoid facilities and halogeton. At this scale of development, these impacts should be negligible if coordination with permittees, field personnel awareness, and weed control measures occur. Whether existing water sources would be impacted due to water draw-down pumping is unknown. The potential for damage to livestock control structures would be minimal due to the level of development. Benefits to livestock operations from existing or new water sources and road infrastructure as a result of CBNG development would continue or be improved.

Impacts would not exceed the significance criteria.

4.6.3.4 Alternative B

The Temporal Development alternative is the same as the Proposed Action in terms of number of wells drilled and acres disturbed both short-term and long-term. The principle difference with the Temporal Development alternative is that the majority of disturbance would occur in phases, with the middle area first, followed by the north and/or south portion in subsequent order. The impacts to livestock operations, would remain the same in the long-term as described under the Proposed Action. However, the short-term impact of the length of time and intensity that impacts occur would vary by region.

Allotments in the middle section, comprising of Adams Ranch, Deep Gulch, Doty Mountain, East Muddy, Headquarters Ranch, JO Pastures, and South Muddy would be affected initially until all build out was completed. This affects four livestock operations. The north section would involve three allotments, Bull Canyon, Fillmore and Sixteen Mile, and two livestock operations. The southern section would involve nine livestock operations and twelve allotments: Airheart Pasture, Baggs Subunit, Brimmer Pastures, Cherokee, Cottonwood Creek, Deep Creek Pasture, Morgan Ranch, Smiley Draw, South Pasture, West Loco, West Wild Cow and Wild Cow.

Differences in impacts to livestock operations relate to the concentrated development on a regional basis. This method of developing all wells, roads, pipelines and facilities would result in a shorter time span of disturbance, and may result in better planning and reduced conflicts if consultation and coordination with livestock operators occurs. Intensity of development would therefore be greater when it did happen, so negative impacts would be amplified. It would also provide additional time to: determine successful reclamation and weed control techniques, and complete drilling and knowledge learned from the Interim Drilling Plan that may reduce impacts to other allotments and livestock operations that are developed later.

Impacts would not exceed the significance criteria.

4.6.3.5 Alternative C

The Spatial Development alternative would proceed with development across the ARPA similar to the Proposed Action alternative, but would have limited acres of disturbance on sensitive sites and/or to protect specific resource values. Examples of some of these sites are steep slopes, soils with high runoff or erosion potential, big game crucial winter range, greater sage-grouse nesting habitat, and aspen/juniper/mountain mahogany plant communities. This would reduce the total surface disturbance by approximately 10,000 acres, or 64 percent less than the proposed action, and long-term disturbance would be reduced by approximately 3,600 acres, or 77 percent less than the proposed action. This would reduce impacts to livestock operations and allotments to varying degrees.

In general, allotments with critical wildlife habitat and high runoff potential soils would have reduced surface disturbance which would result in reduced forage lost or made unusable by dust. Allotments with sensitive soils would have methods employed to reduce erosion or speed up reclamation that would also lower impacts to livestock operations. Posted and enforced speed limits would reduce the young livestock loss to vehicle collisions. Annual coordination with livestock operators would further reduce conflicts with livestock management operations. The reduction in surface disturbance, combined with dust abatement control techniques would reduce the indirect forage loss from dust.

4.6.4 Impacts Summary

Proposed Action. Impacts would include surface disturbance and the associated loss of forage (about 2,026 AUMs). During the LOP, these AUMs are estimated to be replaced and probably increased assuming reclamation efforts are successful. There would be increased death loss, unusable forage due to dust, declining rangeland health and forage productivity, and disruptions to livestock management actions, and the potential for damage to livestock control facilities; however, impacts would not exceed the significance criteria.

Alternative A. Impacts would include surface disturbance and the associated loss of forage as described in the Interim Drilling Plan and associated POD EAs. This would amount to less than ten percent of the forage loss described under the Proposed Action, or between 150 to 200 AUMs. Since this impact is spread across four large allotments, the short-term impact should be minimal. During the LOP, this total is estimated to be replaced or exceeded assuming reclamation efforts are successful. Due to the small scale of development in this alternative, there would be minimal impacts in terms of increased death loss, unusable forage due to dust, declining rangeland health and forage productivity, potential for damage to livestock control structures, and disruptions to livestock management actions.

Alternative B. Impacts would include surface disturbance and the associated loss of forage same as the Proposed Action, but occurring in zones.

Alternative C. Impacts would include reduced surface disturbance (by 64%) and the associated loss of forage. Implementation of the additional mitigation measures would further reduce the direct and indirect loss of AUMs and enhance reclamation of disturbed areas. During the LOP, this total would be replaced or exceeded assuming reclamation efforts are successful. Impacts would be the same in type, but reduced in magnitude and would not exceed the significance criteria.

4.6.5 Additional Mitigation Measures

There are no proposed additional mitigation measures under the proposed action, Alternative A or Alternative B.

Additional mitigation measures for Alternative C:

- The BLM would require that the Operators establish speed limits in the project area, and erect signs in lambing/calving areas, shipping pastures, or adjacent to working corrals to warn vehicle operators.
- The Operators would coordinate annually or more often when necessary with affected livestock operators to minimize disruption during livestock operations, and to discuss/resolve impacts to livestock management facilities.
- Minimize dust from collector roads by maintaining a 95 percent compaction ratio during construction, gravel, and annual treatments of dust abatement product.

4.6.6 Residual Impacts

The Proposed Action would result in residual impacts from death loss, unusable forage due to dust, declining rangeland health and forage productivity, and disruptions to livestock management actions.

The No Action Alternative would result in the same residual impacts, but much reduced.

Alternative B would have the same residual impacts as the proposed action, but concentrated in zones and on fewer operators in a given time period.

Alternative C would result in reduced residual impacts to livestock operations due to reduced death loss, reduced unusable forage due to dust, and fewer disruptions to livestock management activities. Additional mitigation measures in this section and proposed by other resources would significantly reduce, but not eliminate, the potential impacts from gas field development to livestock operations.

4.7 WILDLIFE

4.7.1 Introduction

The principal wildlife impacts likely to be associated with the Proposed Action or action alternatives include: (1) direct and indirect loss of wildlife habitats, (2) displacement of some wildlife species, (3) an increase in the potential for collisions between wildlife and motor vehicles, and (4) an increase in stress to wildlife.

In addition, an analysis of potential wildlife concerns within each section of the ARPA was conducted so that Operators could take the locations of these potential concerns into account when planning and selecting eventual well locations. Mitigation measures that correspond to the respective types of wildlife impacts within any given section would be implemented.

The primary wildlife resource concerns known to be present within the ARPA include: big game crucial winter/transitional ranges; big game migration routes; overlapping big game crucial winter range (multiple species); leks, nesting habitat, and severe winter relief habitat of greater sage-grouse; leks and nesting habitat of Columbian sharp-tailed grouse; and raptor nests.

The wildlife map (Appendix M: Overlapping Wildlife Concerns) represents the currently known locations of wildlife resource concerns within the ARPA. As more field data are gathered, additional areas that include wildlife resource concerns may be identified and mapped. If development occurs in areas of overlapping wildlife resource concerns, mitigation measures for each individual resource would be implemented. This approach provides the Operators with information that can be utilized when developing gas well placement plans. Planned placement of disturbances may avoid individual wildlife resource concerns, or overlapping concerns present within a section.

4.7.2 Impact Significance Criteria

The following criteria were considered in the assessment of impacts associated with the Proposed Action and Alternatives and are the same as those contained in the Draft Rawlins Resource Management Plan (BLM 2004):

- Substantial loss of habitat function or disruption of life history requirements of a species or population segment that would make them eligible for listing under the Endangered Species Act (ESA).
- Decreased viability or increased mortality of threatened and endangered (T&E), proposed, and/or candidate species or adverse alteration of their critical habitats.
- Management actions that result in substantial disruption or irreplaceable loss of vital and high value habitats as defined in the Wyoming Game and Fish Department Mitigation Policy (WGFD 2004).
- Substantial loss of habitat function or disruption of life history requirements of Special Status Species that would preclude improvement of their status.

4.7.3 Direct and Indirect Impacts

4.7.3.1 Direct and Indirect Impacts - Common to All Alternatives

Applicant Voluntarily Committed Measures listed in Appendix K, and the BMP appendix would be implemented.

The Wildlife Monitoring/Protection Plan (Appendix E) would be followed to prevent, reduce, and detect impacts to wildlife and fish species throughout the LOP. This plan serves two purposes. One is to describe the protocols to monitor wildlife responses, habitats, behavioral shifts, etc. The other is to provide protocols to protect wildlife species and track the effectiveness of the monitoring plan. BMP's implemented for other resource concerns may provide indirect protection for a variety of wildlife species.

Potential direct and indirect impacts to wildlife species, common to all alternatives are discussed below. Wildlife habitats directly affected by the proposed project include areas that are physically disturbed by the construction of pads, roads, pipelines, and production facilities;

wildlife habitats indirectly disturbed include areas surrounding directly impacted habitats. Disturbance during construction and production such as human presence, dust, and noise may displace or preclude wildlife use of disturbed areas. Wildlife sensitivity to these impacts varies considerably with each animal species.

Prohibiting construction, drilling, and other activities potentially disruptive to wildlife during sensitive time periods (i.e. winter, brood-rearing), would minimize the probability of displacement, nest abandonment, or reproductive failure during these critical times of the year. To reduce human presence, remote monitoring of project facilities, gating of roads, and noise reduction techniques should be utilized to the greatest extent possible during the production phase. However, habitat loss would still occur outside of this time period, as development would be allowed. Additionally, it does not address the displacement of animals/loss of critical habitat due to the presence and operation of wells, facilities and roads after construction is complete.

Displacement is unavoidable in the short term under all action alternatives, and this displacement has the potential to have the most significant effect on wildlife. Avoidance of disturbed areas would result in wildlife displacement from an area larger than the actual disturbed sites. The extent of displacement would be related to the duration, magnitude, and the visual prominence of the activity, as well as the extent of construction and operational noise levels above existing background levels. Visual prominence of facilities is dependent upon surrounding topography.

Displacement would result in local reductions in wildlife populations if adjacent, undisturbed habitats are at carrying capacity. In this situation animals are either forced into less optimal habitats or they compete with other animals that already occupy unaffected habitats. Possible consequences of such displacement are lower survival, lower reproductive success, lower recruitment, and ultimately lower carrying capacity and reduced populations (Oil and Gas Mitigation Working Group 2004).

Reaction of animals to noise and human presence varies depending on the intensity of the noise source and whether it is continuous or intermittent. Transient loud noises would provoke alarm responses; however, many animals learn to ignore more constant, lower level noise sources that are not associated with negative experiences such as being chased or hunted (Busnel 1978).

The extent of wildlife displacement is impossible to predict for most species since the response severity varies from species to species and can even vary between different individuals of the same species. After initial avoidance, some wildlife species (usually certain birds and rodents and to a lesser extent deer and pronghorn) may acclimate to the activity and begin to reinvade areas previous avoided. This acclimation and reoccupation would be expected to occur following construction and drilling when the project moves into the production phases where less noise and human activity would take place. Acclimation to activity may increase predation on some species.

Construction and drilling noise have the potential of affecting wildlife species at the project site as well as areas surrounding disturbance sites. Man-made construction such as well pads and roads can reduce use of surrounding habitat by wildlife. These impacted sites reduce foraging due to the direct loss of native vegetation from ground disturbance. In addition, there is an area surrounding these sites that tends not to be utilized due to the increased human activity. This "zone" can extend up to a half mile from the developed area. Consequently, development

impacts to wildlife can extend further offsite than the actual amount of disturbed area. Although some individual animals can habituate to the increased infrastructure, it is generally assumed that, over all, the increased human footprint on a previously lightly developed area is detrimental to big game species. In addition to the avoidance response, increased human presence intensifies the potential for wildlife-human interactions ranging from the harassment of wildlife to poaching and increased legal hunting pressure. Also, increased traffic levels on new and existing roads could increase the potential for wildlife-vehicle collisions. Following drilling and well completion operations, noise levels would be reduced because well pumps would be powered by muffled generators. As a result, species might acclimate to the well pad production facilities and utilize habitats immediately adjacent to such sites. This has been observed at other natural gas production sites in Wyoming.

Direct habitat loss from construction would equal approximately 6% of the project area. In addition, dust would directly and indirectly impact 15 – 30% more acreage. These impacts would include habitat avoidance. Indirectly, this may increase inter- and intra-species competition for forage and thermal cover; in areas already fully occupied, density dependant species would be further displaced, possibly outside of the project area. This may force animals to utilize lower quality habitats, which may lead to a reduction in reproduction rates or an increase in predation. The long-term loss/reduced usability of shrub habitat would lead to an increase in use on remaining shrub habitats. This increase of use would then lead to a long-term reduction of shrub habitats outside the immediate project disturbances. A further reduction of shrub habitat from die off caused by overuse would further reduce the habitat quantity and quality available in the long term, resulting in a significant impact.

Habitat fragmentation and isolation are difficult to determine and probably vary species to species but they could occur as a result of gas field developments, which are typically configured as point and linear disturbances scattered throughout broader areas. Although these types of disturbances do not usually create physical barriers to wildlife movement, the effective use of adjacent undisturbed habitats could diminish as densities of well pads, ancillary facilities, and roads increase.

Reclamation of disturbed areas along pipeline and road ROWs, and unused portions of well pads, would result in re-establishment of vegetation in these areas over a relatively short time period. Re-vegetation would continue with the subsequent reclamation of abandoned well sites. Grasses and forbs are expected to become established within the first several years following reclamation; however shrub re-establishment to pre-disturbance levels would not be achieved during the life of this project. Consequently, the total acres disturbed would constitute a long-term loss of shrubs and would not be usable by species dependant upon the shrub component for forage or shelter.

To protect breeding grounds and raptor nest sites, the BLM places a buffer around leks and nests where controlled surface use (CSU) is stipulated (USDI-BLM 1990). The buffer around the leks located within the project area covers 8440 acres or 3.1% of the ARPA. The buffer around nests covers 17,846 acres or 6.6% of the project area. Therefore, most these areas would remain undisturbed for the LOP.

4.7.3.1.1 General Wildlife (Species other than described in Sections below)

The disturbance of wildlife habitat would reduce habitat availability for a variety of small birds and mammals. The temporary disturbances that occur during the 20-year construction period would tend to favor early succession wildlife species such as ground squirrels and horned larks

and would have more impact on mid-to-late-succession species such as sage sparrows, sage thrashers, and voles. The long-term disturbance acres would have a minor effect on wildlife species not dependant upon shrubs. In addition to the direct disturbance acreage, dust would directly and indirectly impact 15 to 30% more acreage. These impacts would include habitat avoidance by birds, mammals, and insects. Indirectly, this may increase inter- and intra-species competition for nesting and foraging areas; in areas already fully occupied, density dependant species would be further displaced, possibly outside of the project area. This may force animals to utilize lower quality habitats, which may lead to a reduction in reproduction rates or an increase in predation.

The primary songbirds (common and BLM sensitive species) that may be displaced by the reduction in habitat are: vesper sparrow, green-tailed towhee, lark sparrow, sage sparrow, sage thrasher, loggerhead shrike, and Brewer's sparrow. Although there is no way to accurately quantify these changes, the displacement would be long term. Birds are highly mobile and would disperse into surrounding areas and utilize suitable habitats to the extent that they are available. The long-term loss/reduced usability of shrub habitat would lead to an increase in use by all species, including big game (see big game section below), on remaining shrub habitats. This increase of use would then lead to a long-term reduction of shrub habitats outside the immediate project disturbances. A further reduction of shrub habitat from die off caused by overuse would further reduce the habitat quantity and quality available for shrub-dependant birds. Standard mitigation measures would indirectly help songbirds during critical time periods, however, impacts on nesting and foraging habitats would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria.

The primary small mammals found on the project area include, but are not limited to, cottontail rabbits, deer mice, various vole species, pocket gophers, white-tailed jackrabbits, Richardson's ground squirrels, and white-tailed prairie dogs. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be minor, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area following interim reclamation. Most of these species would benefit from an increase in grass-dominated vegetation from reclamation.

Development of the project may result in some direct mortality of small birds and small mammals from vehicle collisions; however, this mortality is expected to be negligible and is not likely to significantly reduce populations within the ARPA.

4.7.3.1.2 Big Game

Impacts to big game species may include: (1) the removal and modification of habitat, (2) displacement due to increased human activities, (3) increased potential for vehicular collisions due to increased traffic levels on existing highways, and (4) increased potential harvest success due to easier access. The magnitude of disturbance to big game species would depend upon the season the area is used by each species, the ability of a species to habituate to disturbance, the corresponding drilling schedule, and the density of well field development.

The WGFD classifies big game crucial winter range (CWR) as vital habitats and recommends that habitat function be maintained so that the location, essential features, and species supported by the habitat are unchanged (WGFD 2004). The application of BLM seasonal

restrictions to prevent drilling on CWR between November 15 and April 30 reduces the displacement of big game during the most critical season.

Timely reclamation of well pads, pipelines, and ROWs would provide grass and forb forage within a few years, while sagebrush and other important shrub species would require longer for re-establishment to pre-disturbance levels. With average browse rates on CWR and adjacent transition range already at moderate levels (40-60 percent) during average winters and higher during severe winters; this reduction in usable habitat would lead to increased browse use levels that would result in plant mortality. A ten-year clipping trial study conducted by Colorado State University indicated that repeated plant removal above 60 percent resulted in increased plant mortality of big sagebrush. Displacement of animals, due to project related activities, onto either of these ranges for a longer time period would increase overall browse use levels on both transition and CWR above 60 percent, which would result in plant mortality, lower vigor and declining cover of remaining Wyoming big sagebrush plants. For the most part, impacts described in this and sections below are primarily about CBNG wells, since the actual number and location of deep natural gas wells is speculative at this point.

Pronghorn Antelope

The 43,720 acres of pronghorn crucial winter/yearlong range are located along the western edge of the ARPA (Appendix M: Seasonal pronghorn ranges and migration routes). Approximately 43.5% of the crucial winter/yearlong range in the Baggs pronghorn herd unit is within the ARPA. The remainder of the ARPA is classified as winter/yearlong or spring/summer/fall range.

Prohibiting construction, drilling, and other activities potentially disruptive to pronghorn within CWR from November 15 to April 30, would reduce the probability of displacement during this critical time of the year. During the production phase, there is no equivalent mitigation and animals may be displaced up to 0.25 miles from the source (RFO RMP DEIS 2004). This would lead to increased stress/decreased condition or reproductive rates of the animals as they travel further and may have to use lower quality range. To reduce human presence, remote monitoring of project facilities would be utilized to the greatest extent possible during the production phase.

Several general pronghorn migration routes transverse the ARPA; it is not known how critical these routes are. This project could alter or block pronghorn movements along existing migration routes.

In addition to the direct removal of habitat due to the development of pads and associated ancillary facilities, disturbances from drilling activities and traffic would affect utilization of the habitat adjacent to these areas. However, pronghorn have been found to habituate to increased traffic volumes and heavy machinery as long as the machines move in a predictable manner (Reeve 1984). Pronghorn have also been found to habituate to and inhabit surface mining sites in Wyoming (Segerstrom 1982, Deblinger 1988). Well development operations and deviation from ordinary activities may cause antelope displacement of up to 0.5 miles (Segerstrom 1982, Easterly et al. 1991), but they would likely habituate to activities along roads and continue using habitats in those areas (Reeve 1984). The magnitude of displacement would decrease over time as: (1) the animals have more time to adjust to the circumstance, and (2) the extent of the most intensive activities such as drilling and road building diminishes and more wells are put into production. By the time the field is under full production, construction activities would have ceased, and traffic and human activities would be reduced. Minimizing human presence at well

sites after they have been put into production and timely reclamation of well pads, pipelines, and ROWs would help reduce displacement of pronghorn from the well field. However, fences along Highway 789 create a migration barrier not allowing pronghorn to move from east to west across the highway. Pronghorn found east of this highway are restricted to crucial winter habitat found along Muddy Creek and against Highway 789, creating a trap to animal movement.

Mule Deer

The 74,492 acres of mule deer crucial winter and crucial winter/yearlong range are located within the ARPA (Appendix M: Seasonal mule deer ranges and migration routes). Approximately 27% of the crucial winter and crucial winter/yearlong range in the Baggs mule deer herd unit is within the ARPA. Forty percent of this CWR is on private and state land and is afforded no protection. Therefore, loss of this CWR is likely during the LOP, leading to increased use on public land CWR. Construction activities remove CWR vegetation and increase noise and human activity levels which displaces animals. The critical shrub component within CWR removed would not be replaced (with potentially the exception of mountain sagebrush) to pre-development levels during the life of the project.

Prohibiting construction, drilling, and other activities potentially disruptive to pronghorn within CWR from November 15 to April 30, would reduce the probability of displacement during this critical time of the year. During the production phase, there is no equivalent mitigation and animals may be displaced up 0.75 miles from the source (Rawlins Draft RMP 2004). This would lead to increased stress/decreased condition or reproductive rates of the animals as they travel further and may have to use lower quality range. To reduce human presence, remote monitoring of project facilities would be utilized to the greatest extent possible during the production phase.

Several mule deer migration routes transverse the ARPA. A research project initiated by the BLM and WYGFD in February of 2005, funded by two of the operators, should help delineate the migration routes utilized by mule deer on the ARPA. When information is available from this research, additional mitigation would be placed on development for the protection of mule deer migration corridors. Meanwhile, this project could alter or block mule deer movements along existing migration routes.

In addition to the direct removal of habitat due to the development of pads and associated ancillary facilities, disturbances from drilling activities and traffic would affect utilization of the habitat immediately adjacent to these areas. Mule deer, however, are adaptable and may adjust to non-threatening, predictable human activity (Irby et al. 1988, Gusey 1986). However, the Sublette mule Deer Study, using GPS collars, found that winter mule deer habitat selection and distribution patterns have been affected by development, specifically road networks and well pads. Sawyer found no evidence of acclimation behavior. During three years of study, mule deer had higher probability of use in areas farther away from well pads as development progressed. Predictive maps also suggest that some habitats considered “high probability of use” areas prior to development, changed to “low probability of use” areas as development progressed, and visa versa. Indirect habitat loss can be substantially greater than the direct loss of habitat to roads and well pad construction and that reduction in winter range size and quality of available habitat may decrease the carrying capacity of the overall winter range (Sawyer 2004). This suggests that within the ARPA, indirect impacts such as displacement from activities, dust from roads, and competition for forage within the already poor condition CWR habitat may lead to reduced mule deer numbers and die offs from animals going onto CWR in poorer health with reduced body reserves.

Elk

Approximately 41,000 acres or 20% of the crucial winter/yearlong range in the Sierra Madre elk herd unit is within the ARPA (Appendix M: Seasonal Elk Ranges and Migration Routes). Several elk migration routes transverse the ARPA; it is not known how critical these routes are. This project could alter or block elk movement along existing migration routes.

Construction activities remove CWR vegetation and increase noise and human activity levels which displace animals. However, much of the CWR is on steeper south and west facing slopes that would be avoided during development. The amount of vegetation disturbed is not as important as the noise and activity levels that would still occur and result in displacement of elk. In addition to the direct removal of habitat due to the development of pads and associated transportation facilities, disturbances from drilling activities and traffic would affect utilization of the habitat adjacent to these areas (Powell 2003). Elk are more sensitive to human activities than pronghorn or mule deer, and they may be displaced from construction areas by 0.75 - 2 miles (Brekke 1988, Gusey 1986, Hiatt and Baker 1981). Displacement would be reduced in areas with topographic barriers (Edge and Marcum 1991). Elk would likely habituate to the physical presence of gas wells (Ward et al. 1973, Ward 1976, Hiatt and Baker 1981, Perry and Overly 1976). However, elk rarely adjust to continued human presence required during the production phase of the project (Thomas and Toweill 1982). With the increase in roads and potential recreational access to the area, displacement of elk is extremely likely during all phases of development. During the production phase, there is no equivalent mitigation and animals may be displaced up one mile from the source (Rawlins Draft RMP 2004). This would lead to increased stress/decreased condition or reproductive rates of the animals as they travel farther and may have to use lower quality range. To reduce human presence, remote monitoring of project facilities would be utilized to the greatest extent possible during the production phase.

Overlapping Big Game Crucial Winter Range

Areas of overlapping big game CWR are of greater importance because they provide crucial habitat for more than one species of big game. There are several areas of overlapping big game CWR located in the ARPA (Appendix M: Overlapping Crucial Winter Ranges). The combinations of overlapping big game CWR include the following: elk/mule deer 3,038 acres; mule deer/antelope 22,637 acres. Forty percent is on private and state lands where there are no protections against disturbance of animals during critical time periods.

Indirectly, this may increase inter- and intra-species competition for forage and thermal cover; in areas already at carrying capacity, density dependant species would be further displaced. This may force animals to utilize lower quality habitats, which may lead to a reduction in reproductive rates or an increase in predation.

4.7.3.1.3 Upland Game Birds

Greater Sage-grouse.

Greater sage-grouse are abundant within the ARPA, due to the high amount and diversity of suitable habitat, lack of habitat fragmentation, and the close proximity of upland and riparian habitats. In addition, all habitats needed to fulfill the life history requirements of this species are found adjacent to one another. Potential impacts to greater sage-grouse include: loss of nesting or early brood-rearing habitat; decreased population productivity caused by loss of nesting or

early brood-rearing habitat; reduced utilization of suitable habitats due to indirect disturbance; loss of winter habitat; and displacement of birds into lower quality habitats.

Potential sources of direct impacts to greater sage-grouse include excessive noise levels proximal to occupied leks; disruptive human activities that occur during the daily time period in which courtship and breeding, nesting, brood-rearing, and foraging activities take place; and habitat loss from construction of project facilities. Noise levels interfere with bird communication during mating periods resulting in lower bird attendance at leks. Disruptive human activities alter normal bird behavior, increases nest abandonment, and may displace birds into less desirable habitats. Construction of facilities and roads creates a long-term loss of greater sage-grouse habitat and increases fragmentation of remaining habitat. All of these impacts lead to lower productivity and long-term decline in the population of this species.

Of greater concern is the indirect loss of habitat resulting in bird displacement and fragmentation of nesting and early brood-rearing habitat. Sources of indirect impact primarily relate to dust settling on vegetation and loss of sagebrush habitat due to over-browsing by antelope and mule deer. Dust reduces the palatability and production of forbs and shrubs used by grouse. Over-browsing by big game on ranges shared with grouse would reduce quality and/or abundance of nesting, brood-rearing, and winter habitats, and forage.

Potential greater sage-grouse nesting habitat covers 92% of the ARPA. In the long-term, recovery of shrubs to pre-disturbance levels would not occur during the life of the project. Therefore, there would be a long term loss of nesting habitat.

Sage grouse may repopulate an area following energy development but may not attain population levels that occurred prior to development (Braun 1998). Most nests abandoned are directly or indirectly related to human activity. Likelihood of abandonment is higher when nests are disturbed early in incubation period (Remington and Braun 1991).

Columbian Sharp-tailed Grouse.

Six occupied Columbian sharp-tailed grouse lek locations have been documented on or within one mile of the ARPA, which comprise 27% of the leks within the Rawlins Field Office (Appendix M: Columbian sharp-tailed grouse lek locations). Potential Columbian sharp-tailed grouse nesting habitat (habitat located within one mile of an occupied lek) covers approximately 4,900 acres or 1.8% of the ARPA. Leks are not located on BLM lands, however 785 acres of nesting and brood-rearing habitat are. Wintering habitat for sharp-tailed grouse (serviceberry/mixed mountain shrub habitat) totals 287 acres, of which 278 acres are on BLM.

Potential sources of impact to sharp-tailed grouse include excessive noise levels proximal to occupied leks, and disruptive human activities that occur during the daily time period in which courtship and breeding activities take place. As no leks are located on BLM managed lands, the potential for disturbance during courtship and breeding periods is likely as there are no timing restrictions for surface disturbing or other disruptive activities. Also, in the long-term, recovery of shrubs to pre-disturbance levels would not occur during the life of the project for sharp-tailed grouse nesting and brood-rearing habitat.

The application of avoidance and mitigation measures on BLM lands would help to reduce stress to sharp-tailed grouse during nesting and brood-rearing periods. There are no measures to protect the habitat from being removed by project activities outside this spring period on BLM lands or at any time on private and state lands.

Wintering Areas for Grouse.

Wintering areas (as they are mapped) would be protected from surface disturbing activities from November 15 to March 14. Approximately 200 acres of sever winter relief areas (SWR), of which 174 acres are on BLM, have been identified and mapped so far. Mapped wintering habitat for sharp-tailed grouse (serviceberry/mixed mountain shrub habitat) totals 287 acres, of which 278 acres are on BLM. Activities would be allowed outside this timing period and habitat would be removed. This would result in habitat loss as well as potential displacement of wintering birds.

4.7.3.1.4 Raptors

The potential impacts that the project could have on raptors include: nest abandonment and/or reproductive failure due to project activities or increased public access, reductions in prey populations, mortality from vehicle collisions, loss of nesting habitat, decreased population recruitment, and reduced utilization of suitable habitats.

There are 357 raptor nests located within the ARPA, with an additional 185 raptor nests within one mile of the ARPA boundary (one mile seasonal protection) totaling 542 nests. The total acreage around nests, buffered by one mile of seasonal protection, totals 173,483 acres or 64 % of the ARPA.

The development of the project would disturb habitat for several prey species. The amount of short-term change in prey base populations created by construction is expected to be minimal in comparison to the overall level of small mammal populations. While prey populations on the project area would likely sustain some reduction during the development phase of the project, most prey species would be expected to rebound to pre-disturbance levels following initial reclamation. Once reclaimed, these areas would likely promote an increased density and biomass of small mammals that is comparable to those of undisturbed areas (Hingtgen and Clark 1984). For these reasons, no measurable long-term reductions are anticipated to the prey base. However, prey populations may be displaced due to dust and habitat loss. In turn, those raptors (i.e. prairie falcon and burrowing owl) dependant on small birds and insects may be indirectly affected.

Some raptors feed on carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed. The potential for such collisions can be reduced by requiring that drivers undergo training that describes the circumstances under which vehicular collisions are likely to occur and the measures that can be taken to minimize them.

4.7.3.1.5 Fish

Refer to Special Status Species for impacts to Sensitive Fish Species.

4.7.3.2 Proposed Action

Development would alter or remove approximately 15,800 acres of wildlife habitat over the next twenty years. However, reclamation of disturbed habitats would commence immediately and continue throughout the 20-year construction period, resulting in a short-term recovery of grass-dominated habitat. This reclamation would reduce the area disturbed by 60 percent, to 6,240

acres. Long-term recovery of shrubs to pre-disturbance levels would not occur during the life of the project. There would be 54 acres of pre- and 22 acres of post- reclamation disturbance with the maximum eight pad locations per section.

Impacts are the same as identified in "Common to All" above, unless discussed below.

4.7.3.2.1 General Wildlife (Species other than described in Sections below)

The long-term disturbance would have a minor effect on wildlife species not dependant upon shrubs. Impacts to songbirds that are dependant upon shrub habitats for nesting and foraging would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria.

4.7.3.2.2 Big Game

Pronghorn Antelope

The acreage disturbance and the actual number of pads per section would fall under a high impact post-reclamation. The direct loss/reduced usability of Wyoming big sagebrush would increase use on remaining shrubs, resulting in shrub health decline outside the immediate project disturbances. This would have the greatest impact to antelope due to their extreme reliance upon sagebrush (96% of their diet) during winter. This level of development within pronghorn CWR, compounded by the current condition of the crucial winter habitat would exceed the significance criteria.

Mule Deer

The acreage disturbance and the actual number of pads per section would fall under a high impact post-reclamation. This level of development within mule deer transitional range and CWR, compounded by the current poor condition of the crucial winter habitat would exceed the significance criteria.

Elk

Although actual acreage disturbance would fall under a "high" impact post-reclamation, there would be an "extreme" impact to elk based on the actual number of pads (8 pads per section). With this level of development, impacts to elk CWR would exceed the significance criteria.

4.7.3.2.3 Upland Game Birds

Greater Sage-grouse.

The proposed action habitat disturbances would equate to a maximum direct loss of 9% of the available nesting habitat (eight locations per section with associated roads and facilities). However, the acreage disturbed by this alternative would fall into the high impact category.

Of greater concern is the indirect loss of habitat resulting in bird displacement and fragmentation of nesting and early brood-rearing habitat. At eight locations per section impact zones surrounding each well pad, facility and road corridor begin to overlap, thereby reducing habitat effectiveness over much larger, contiguous areas. Human, equipment and vehicular activity and noise impacts are also more frequent and intensive (WGFD 2004).

The application of avoidance and mitigation measures would help reduce the loss of habitat and stress to greater sage-grouse in proximity to leks on public lands. Based on research conducted in Wyoming, only 45% of nests would be afforded seasonal protection as they are within the two-mile buffer of leks. Of the suitable nesting habitat, 21% is outside the two-mile buffer and would be afforded no seasonal protection. Habitat loss would continue outside the ¼ mile protected buffer around leks. However, the long term loss of shrubs combined with the indirect impacts on the habitat, such as dust, noise, and continued human presence during the drilling and production phase would result in habitat loss and disturbance levels exceeding the significance criteria.

Columbian Sharp-tailed Grouse.

The application of avoidance and mitigation measures in this alternative would help to reduce stress to nesting and brood-rearing and wintering sharp-tailed grouse. However, because of the magnitude of habitat loss and continued human presence during the production phase of the project, impacts would exceed the significance criteria.

Wintering Areas.

The timing stipulation prevents winter disturbance to grouse, but does not prevent the direct loss of wintering areas outside of this time period. Loss of this habitat would lead to lower productivity and long-term decline in the population of these species.

4.7.3.2.4 Raptors

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria.

4.7.3.2.5 Fish

Refer to Special Status Species for impacts to Sensitive Fish Species.

4.7.3.3 Alternative A – No Action

Under Alternative A, drilling would continue under the interim drilling plan. The remainder of the area would remain undeveloped.

4.7.3.4 Alternative B

The temporal development involves the same number, rate and spacing of wells to be drilled as in the proposed action. However, the principle difference would be that the majority of development would occur in three phases with the center portion of the project area (Doty Mountain Pod, Sundog/Cow Creek POD and Blue Sky Pod) being developed first over a five to six year period. The initial phase would involve approximately 950 CBNG well locations. There would be continued drilling, of approximately 100 additional wells, within previously analyzed PODs, concurrently with development of the initial phase. Development would then be shifted to the second phase in the northern portion and the third phase in the southern portion of the project area. The entire project area would still be developed over a twenty year period, with approximately 95% of the CBNG wells and 75% of the conventional wells being drilled within 15 years. In terms of disturbance to wildlife and their habitats, this phased approach would

potentially provide "safe-haven" areas in two thirds of the project area during the development phases of the ARPA. However, this does not take into account that those areas would be already occupied, may be of lower quality or not be suitable, or may not be available due to migration distances or potential barriers. They may not provide enough habitat for the areas lost. Lessons learned during the earlier phases may change how the next phase of development proceeds (adaptive management through monitoring).

4.7.3.4.1 General Wildlife (Species other than described in Sections below)

This alternative would benefit some wildlife species more than others, depending on their mobility and adaptability. Mobile and less tolerant species such as sagebrush dependant birds could potentially move to adjacent areas to avoid direct and indirect impacts. Impacts would be the same as those described in the proposed action however, they would occur mainly on one third of the project area, at any one time.

4.7.3.4.2 Big Game

Most pronghorn CWR is located along the western edge of the project. The transition range is located through the middle of the project north to south. Therefore, development would disturb one third of the CWR and transition range over the first five to six years. Even though two thirds of these ranges would remain intact, development would occur in the middle, fragmenting both. The increase in use on undisturbed ranges would lead to a long-term decline in health of the ranges.

Mule deer CWR lies within the southern and northern portions of the project. Therefore, the first phase of development would have the least amount of disturbance to mule deer CWR; however disruption of animal movements would occur within transition habitat and migration corridors. Two of the project proponents have funded a study to better understand and identify mule deer use and movement within the project area. This alternative may provide the study more time to better understand mule deer movements and allow for protection of migration corridors.

Elk CWR occurs within all phases of the project. During the first phase of development, impacts to CWR habitat would be the greatest. The first phase of development would effectively fragment the CWR.

Similar to the proposed action, with the same number of pad locations and spacing, this level of development within transitional ranges and CWR, compounded by the current poor condition of the crucial winter habitat would exceed the significance criteria.

4.7.3.4.3 Upland Game Birds

Greater sage-grouse are found throughout the project area. Therefore, impacts from this alternative would be the same within each portion of the phased alternative. This alternative would benefit greater sage-grouse in the short-term by concentrating development within one third of the project area over the first five to six years. Suspension of grazing use would leave more residual grass cover and forbs on grouse habitat, which in turn would benefit grouse nesting and brood-rearing. In the long-term, however, the decline in health of CWR and transitional ranges for big game would further reduce habitat quality and quantity for grouse, potentially leading to a decline in population numbers.

Columbian sharp-tailed grouse are found within the southern phase of development. Within the first phase of development Columbian sharp-tailed grouse are found outside the eastern edge within the Sand Hills ACEC. This alternative would ultimately disturb Columbian sharp-tailed grouse habitat during the southern phase of development and grouse could be displaced from the project area.

Similar to the proposed action, with the same number of pad locations and spacing, this level of development within grouse habitat, would exceed the significance criteria.

4.7.3.4.4 Raptors

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria.

4.7.3.5 Alternative C

The Spatial Development alternative would proceed with development across the ARPA similar to the Proposed Action alternative, but would be constrained by critical/sensitive resource concerns. These sites would have additional protective measures beyond what is already provided by applying standard mitigation stipulations (Appendix E) and BMPs. Examples of these sensitive sites are: steep slopes, soils with high runoff potential, big game CWR, greater sage-grouse nesting and brood-rearing habitat, and juniper/true mountain mahogany/serviceberry plant communities. Because of these sensitive issues, there would be less surface disturbance allowed per section on BLM lands. This would reduce the total surface disturbance by approximately 64 percent less than the proposed action. Long-term disturbance would be reduced by approximately 77 percent less than the proposed action. There would be less than 20 acres of pre-reclamation and 5 acres of post-reclamation surface disturbance with a maximum of 4 pads per section in grouse nesting and brood-rearing habitat and CWR on BLM lands. This would reduce impacts on different wildlife species to varying degrees.

For instance, juniper/true mountain mahogany/serviceberry plant communities would be avoided across the project area and no disturbance would be allowed in these communities within SMA boundaries. This would aid in efforts to restore them to a more healthy condition to meet Rangeland Health Standard #3. These vegetation communities provide important habitat components for big game and grouse.

The overall reduction in acres initially disturbed would reduce habitat fragmentation and indirectly increase potential recruitment of native species re-establishing disturbed sites. This would decrease the overall habitat loss and displacement effects to wildlife species, as well as reduce impediments within movement corridors. A reduction in disturbance of wildlife habitat by 64% would benefit all species and reduce the time required, long term, to return the functionality of the habitat in the project area. These benefits would be realized to the greatest extent in the central and southern portions where there is a preponderance of BLM lands. The extreme southern portion and the northern half would realize some benefit of these additional mitigations, but their effectiveness would be reduced due the lack of equivalent mitigation on private and state lands.

4.7.3.5.1 General Wildlife (Species other than described in Sections below)

Under this alternative, addition mitigation would be applied to minimize impacts to important CWR, important winter habitat for grouse, greater sage-grouse nesting and brood-rearing

habitats. This mitigation to reduce total acres of disturbance would directly and indirectly benefit small birds and mammals. This would reduce disturbance in essential habitats during critical time periods for a diversity of wildlife species. This can include, but is not limited to nesting, brood-rearing, thermal cover and transitional habitat use for a diversity of small birds, mammals. Due to these factors, impacts would not exceed the significance criteria for small mammals and songbirds.

4.7.3.5.2 Big Game

Although the exact locations are not known, the placement of pads, roads, and other facilities within the ARPA would be focused on areas that are on and adjacent to the existing pods. As build out occurs from the pods big game CWR would be impacted. Below are the calculation of the percentage of CWR to be impacted (by species of big game) within the ARPA and what percent of the project area would be affected by the additional mitigation. This does not take in to account the impacts to transitional range or migration corridors.

The following acreage figures are for direct habitat loss: (conversion of habitat to pads, roads, compressor stations, etc.). There would be less than 20 acres of pre-reclamation and 5 acres of post- reclamation with the maximum 4 pads per section (resource roads and pads, not collector roads) within CWR.

The pronghorn herd units to be affected by the ARPA are the Bitter Creek and Baggs units. Out of 99,574 acres of CWR habitat found within the Bitter Creek unit, 1,402 acres would be disturbed or 0.5%. Out of 95,557 acres of CWR habitat found within the Baggs unit, 41,501 acres would be disturbed or 43%. Twenty-four percent of the CWR is on private and state lands; additional mitigation would not be applied to those lands. Additional mitigation would occur on approximately 12% of the ARPA. Reduced impacts to transition range would help maintain the health of CWR.

The mule deer herd unit to be affected by the ARPA is the Baggs unit. Out of 270,893 acres of CWR habitat found within the unit, 73,472 acres would be disturbed or 27%. Forty-two percent of the CWR is on private and state lands; additional mitigation would not be applied to those lands. Additional mitigation would occur on approximately 16% of the ARPA. Reduced impacts to transition range would help maintain the health of CWR.

The elk herd units to be affected by the ARPA are the Petition and Sierra Madre units. No CWR for the Petition unit is found within the ARPA. Out of 178,697 acres of CWR habitat found within the Sierra Madre unit, 40,840 acres would be directly disturbed or 23%. Elk CWR additional mitigation would be applied to approximately 15% of the ARPA. Seventeen percent of the CWR is on private and state lands; additional mitigation would not be applied to those lands. Additional mitigation would occur on approximately 10% of the ARPA.

Under this alternative, the reduced direct acreage disturbance and number of pads would reduce impacts to the moderate category for pronghorn and mule deer CWR. Direct and indirect impacts to pronghorn CWR would be reduced so that impacts would not exceed the significance criteria. Direct impacts to mule deer CWR, combined with indirect impacts would still exceed the significance criteria. For elk CWR, impacts would be reduced to the high category, which would still exceed the significance criteria.

4.7.3.5.3 Upland Game Birds

There would be less than 20 acres of pre-reclamation and 5 acres of post- reclamation with the maximum 4 pads per section (resource roads and pads, not collector roads) within nesting and brood-rearing habitat.

Ninety-two percent of the project area contains brood-rearing and nesting habitat for greater sage-grouse. Direct disturbance would be reduced by 64% on public lands, reducing long-term loss of greater sage-grouse habitat to the moderate category. Short-term suspension of grazing use in some pastures would leave more residual grass cover and forbs on grouse habitat, which in turn would benefit those grouse nesting and brood-rearing in these localized areas. However, the indirect impacts (displacement from construction and drilling noise, traffic, increased human activity) would still exceed the significance criteria.

Although winter conditions generally have little effect on greater sage-grouse populations (Call and Maser 1985, Beck and Braun 1978), the protection of those habitats utilized during the most severe winters would greatly facilitate the survival of greater sage-grouse during extreme winters. The avoidance of SWR habitat would eliminate the loss of these critical areas.

Columbian sharp-tailed grouse are found within the southern half of the ARPA. Surface disturbing activities would be prohibited in serviceberry/mixed mountain shrub habitat within the SMA boundaries which would also protect wintering habitat for sharp-tailed grouse on 278 acres (97%). Soil mitigation, restricting surface disturbance on high runoff potential soils, would also indirectly protect nesting and brood-rearing habitat. Direct disturbance would be reduced by 64% on 785 acres (16%), reducing direct impacts to the moderate category. Disturbance would not be reduced on the other 84% on private and state land, maintaining impacts in the high category. This combined, with other indirect impacts would still exceed the significance criteria.

4.7.3.5.4 Raptors

Under this alternative, impacts would be reduced by minimizing the amount of surface disturbance within sensitive/critical resource areas. With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria.

4.7.4 Impacts Summary

4.7.4.1 Proposed Action

Standard mitigation measures would indirectly help songbirds during critical time periods, however, impacts on nesting and foraging habitats would be significant. The magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria.

The impact to small mammals is likely to be minor, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area following interim reclamation. Most of these species would benefit from an increase in grass-dominated vegetation from reclamation.

This level of development within big game CWR and transition range, compounded by the current condition of these ranges would exceed the significance criteria.

The application of the winter timing stipulation would only protect grouse during this critical time period. This does not prevent the direct loss of wintering areas for grouse outside of this time period. The long term loss of shrubs combined with the indirect impacts on the habitat, such as dust, noise, and continued human presence during the drilling and production phases would result in the proposed action activities exceeding the significance criteria for greater sage-grouse and Columbian sharp-tailed grouse.

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria for raptors.

4.7.4.2 Alternative B

Similar to the proposed action, the magnitude of habitat loss, and continued human presence during the production phase of the project, would exceed the significance criteria for songbirds.

Similar to the proposed action, with the same number of pad locations and spacing, this level of development within transitional ranges and CWR, compounded by the current poor condition of the crucial winter habitat would exceed the significance criteria.

Similar to the proposed action, with the same number of pad locations and spacing, this level of development within grouse habitat, would still exceed the significance criteria.

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria for raptors.

4.7.4.3 Alternative C

Impacts would not exceed the significance criteria for small mammals and songbirds.

Direct and indirect impacts to pronghorn CWR would be reduced so that impacts would not exceed the significance criteria. Direct impacts to mule deer CWR, combined with indirect impacts would still exceed the significance criteria. For elk CWR, impacts would be reduced to the high category, which would still exceed the significance criteria.

Long-term loss of habitat to greater sage-grouse and Columbian sharp-tailed grouse, combined with indirect impacts (see Common to All section above) would still exceed the significance criteria.

With the application of avoidance and mitigation measures, impacts are not expected to exceed the significance criteria for raptors.

4.7.5 Additional Mitigation Measures

4.7.5.1 Proposed Action

There are no additional measures proposed.

4.7.5.2 Alternative A

There are no additional measures proposed.

4.7.5.3 Alternative B

There are no additional measures proposed.

4.7.5.4 Alternative C

Additional mitigation measures implemented for other resource concerns may provide indirect protection for a variety of wildlife species. In addition to the requirements in Appendices E, B, H, and J, the following mitigation measures (Appendix L) are recommended to reduce potential impacts to wildlife:

- Low impact road design for resource roads (roads into individual pads) on slopes < 5%, if road can be built with no side slopes. This would include ditch-witching utilities within the ROW, brush beating, some type of fabric or matting and gravel.
- Improve road surface on newly constructed or improved local and collector roads with 95% compaction on the road base and non-chlorine dust abatement product or suitable alternative treatment each year
- Reduce pad density to 4 locations per section and the associated infrastructure and limit initial disturbance (i.e. short-term) total to < 20 acres per section in CWR, grouse nesting and brood-rearing habitat, soils with high runoff potential, vegetation communities on >8% slopes
- Avoid surface disturbances within aspen, juniper woodland, True mountain mahogany, and serviceberry communities
- Limit surface disturbances within the silver sagebrush/bitterbrush vegetation community
- No surface disturbance within identified severe winter relief habitat for greater sage-grouse
- No surface disturbance within identified winter habitat for Columbian sharp-tailed grouse
- Road density would be targeted for less than 3 miles/mile^2, transportation and well access roads would utilize existing road paths where feasible, no new road crossings of Muddy Creek, use only non-chlorine deicing and dust control agents, convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement, and no surface disturbances within aspen, juniper-woodland, true mountain mahogany, and serviceberry communities within the Muddy Creek SMA
- Road density would be targeted for less than 3 miles/mile^2, convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement, and no surface disturbances within aspen, true mountain mahogany, and serviceberry communities within the Cow Butte/Wild Cow SMA
- Net reduction in road density to less than 3 miles/mile^2, transportation and well access roads would utilize existing road paths where feasible, use only non-chlorine deicing and dust control agents, convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement, no surface disturbance within the 18 acres surrounding JO Ranch Headquarters, and limit surface disturbances within the silver sagebrush/bitterbrush community to < 20 acres/mi^2 within the Sand Hills SMA.

4.7.6 Residual Impacts

4.7.6.1 Proposed Action

Standard mitigation measures would not completely alleviate the magnitude of habitat loss and continued human presence during the production phase of the project on nesting and foraging habitats for songbirds.

Standard mitigation measures would not completely alleviate the long term loss of shrubs, nor the indirect impacts on habitat, such as dust, noise, and continued human presence during the drilling and production phase within big game transition and CWR, and grouse habitat.

4.7.6.2 Alternative A - No Action

There would be no residual impacts.

4.7.6.3 Alternative B

Similar to the proposed action, with the same number of pad locations and spacing, standard mitigation measures would not completely alleviate the magnitude of habitat loss and continued human presence during the production phase of the project on nesting and foraging habitats for songbirds.

Similar to the proposed action, with the same number of pad locations and spacing, standard mitigation measures would not completely alleviate the long term loss of shrubs, nor the indirect impacts on habitat, such as dust, noise, and continued human presence during the drilling and production phase within big game transition and CWR, and grouse habitat.

4.7.6.4 Alternative C

Although the additional mitigation would reduce the long term loss of shrubs, the indirect impacts on habitat, such as dust, noise, and continued human presence during the drilling and production phase, disturbance to mule deer and elk transition and CWR, and grouse habitat would occur.

4.8 SPECIAL STATUS PLANT, WILDLIFE, AND FISH SPECIES

4.8.1 Introduction: Threatened, Endangered, Proposed, Candidate or Sensitive Species of Plants, Wildlife, and Fish

The FWS has determined that nine species, which are listed under the ESA as either threatened or endangered or as proposed or candidate species are potentially present within the Rawlins BLM Field Office area (USDI-FWS 2004a; Table 3-32). Additionally, ten species found downstream of the Rawlins Field Office area in the Platte and Colorado River systems may potentially be impacted if water depletions occur. More detailed information on threatened, endangered, and proposed species is presented in the BA for the Atlantic Rim Project (Appendix G). A total of 36 species (7 plants, 6 mammals, 16 birds, 3 amphibians, and 4 fish) occur on the BLM Sensitive Species List in the RFO and may occur on or near the ARPA.

4.8.2 Impact Significance Criteria

The following criteria were considered in the assessment of impacts associated with the Proposed Action and All Alternatives and are the same as those contained in the Draft Rawlins RMP (BLM 2004). Impacts to species of special concern including threatened, endangered, proposed, candidate and sensitive species would be considered significant if any of the following was to occur:

- Substantial loss of habitat function or disruption of life history requirements of a species or population segment that would make them eligible for listing under the Endangered Species Act (ESA).
- Decreased viability or increased mortality of threatened and endangered (T&E), proposed, and/or candidate species or adverse alteration of their Critical habitats.
- Management actions that result in substantial disruption or irreplaceable loss of vital and high value habitats as defined in the Wyoming Game and Fish Department Mitigation Policy (WGFD 2004).
- Substantial loss of habitat function or disruption of life history requirements of Special Status Species that would preclude improvement of their status.
- Actions preclude attainment of conservation goals as stated in conservation plans and strategies for special status species

4.8.3 Direct and Indirect Impacts

4.8.3.1 Direct and Indirect Impacts Common to All Alternatives

The Wildlife Monitoring/Protection Plan (Appendix E) would be followed to prevent, reduce, and detect impacts to threatened, endangered, proposed, and candidate wildlife and fish species throughout the LOP. This plan serves two purposes. One is to describe the protocols to monitor wildlife responses, habitats, behavioral shifts, etc. The other is to provide protocols to protect wildlife species and track the effectiveness of these protections.

Wildlife habitats directly affected by the proposed project include areas that are physically disturbed by the construction of wells, roads, pipelines, and production facilities. Wildlife habitats indirectly impacted might not be physically disturbed, but the suitability of these habitats is affected by direct disturbances in nearby areas. Disturbance during construction and production phases of development such as human presence, dust, and noise may displace or preclude wildlife use of disturbed areas. Wildlife sensitivity to these impacts varies considerably with each animal species.

4.8.3.2 Proposed Action

As described in detail in Chapter 2, a total of 1,800 new coal bed natural gas wells and 200 conventional natural gas wells would be drilled and developed under this alternative during the next 20 years with an expected LOP of 30-50 years. Well placement within the ARPA is not known at this time, however, development would occur across the analysis area and within and near existing PODs that were developed under the Interim Drilling Policy (Appendix A).

The following T&E, Proposed, or Candadate species are not known to occur in the ARPA and would not be impacted by the project: blowout penstemon, Colorado butterfly plant, Ute Ladies'-tresses, Canada lynx, Preble's meadow jumping mouse, yellow-billed cuckoo, whooping crane, interior least tern, piping plover, and Eskimo curlew, and Wyoming toad. Additionally, there would be no water depletions in the North Platte Drainage so there would be no impacts to the western prairie fringed orchid. Species which may be affected, as well as fish species are discussed below.

<u>Black-Footed Ferret.</u> Development of the Proposed Action would likely result in direct disturbance of some portions of prairie dog colonies. Surveys for black-footed ferrets would be required prior to ground disturbing activities within prairie dog colonies located in the Dad Complex. The remaining white-tailed prairie dog colonies within the ARPA are in the "block clearance" area, where surveys for black-footed ferrets are no longer warranted. Implementation of the proposed action may affect but is not likely to adversely affect the black-footed ferret.

<u>Bald Eagle.</u> Bald eagles have been observed on the project area primarily during December, January, and February (WGFD 2003). The majority of bald eagle sitings are in the southern portion of the ARPA, close to the Little Snake River. Bald eagles may utilize the project area for foraging during winter months because a large portion consists of winter range for antelope, mule deer, and elk.

The potential for vehicle-animal collisions would increase as a result of increased vehicular traffic associated with the project. Because bald eagles commonly feed on carrion, particularly during the winter months, the presence of road-killed wildlife on and adjacent to the access roads is an attractant. Eagles feeding on these carcasses are in danger of being struck by moving vehicles. Any increase in the death rate of bald eagles from vehicular collisions would constitute a significant impact. Because the potential for an increase in wildlife-vehicle-eagle encounters exists, the bald eagle may be affected, but is not likely to be adversely affected.

<u>Threatened and Endangered Fish Species.</u> Four federally endangered fish species may occur as downstream residents of the Colorado River system: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USDI-FWS 2003). One federally endangered fish species, the pallid sturgeon (*Scaphirhynchus albus*), may occur as a downstream resident of the Platte River system in Nebraska.

Though they currently exist only downstream of the ARPA, water draining from the ARPA affects the downstream habitat for these species. Under the *Recovery and Implementation Program for Endangered Fish Species in the Upper Colorado River Basin* (RIP), "any water depletions from tributary waters within the Colorado River drainage are considered as jeopardizing the continued existence of these fish." Tributary water is defined as water that contributes to instream flow habitat. Depletion is defined as water which would contribute to the river flow if not intercepted and removed from the system. The BLM retains discretionary authority over individual projects within the area for the purpose of endangered species consultation. If the recovery program is unable to implement the RIP in a timely manner or make sufficient progress in recovery of these endangered species, re-initiation of Section 7 consultation may be required so that new reasonable and prudent alternatives can be developed. The FWS has determined that progress made under the RIP has been sufficient to merit a waiver of the mitigation fee for depletions of 100 acre-feet per year or less (Memorandum dated March 9, 1995 to Assistant Regional Director, Ecological Services, Region

6, from Regional Director 6, "Intra-Service Section 7 Consultation for Elimination of Fees for Water Depletions of 100 acre-feet or Less from the Upper Colorado River Basin"). The Proposed Action would deplete approximately 10.3 acre-feet of water per year, and thus a mitigation fee waiver would be applicable.

Under the Proposed Action, the primary source of potential risks to these fish species is increases in suspended sediments and sedimentation from land disturbance from project activities. No produced water from the ARPA would be discharged to the Little Snake River drainage; therefore, produced water discharges do not pose a risk to these species. Accidental releases of produced waters or other materials could occur. However, these materials would become highly diluted before they would reach any downstream waters where these species occur; consequently, the potential risks from such occurrences are negligible.

Colorado Pikeminnow. Suitable habitat for the Colorado pikeminnow does not exist on the ARPA. Suitable habitat does exist downstream of the ARPA in the Yampa and Green Rivers; however, the Proposed Action is not expected to affect this habitat provided that mitigation measures for water resources and soils outlined in this document are implemented.

Bonytail. Suitable habitat for adult bonytail is absent from the ARPA. Suitable habitat does exist downstream of the ARPA in the Yampa and Green Rivers; however, the Proposed Action is not expected to affect this habitat provided that mitigation measures for water resources and soils outlined in this document are implemented.

Humpback Chub. Suitable habitat for adult humpback chub is absent from the ARPA. Suitable habitat does exist downstream of the ARPA in the Yampa and Green Rivers; however, the Proposed Action is not expected to affect this habitat provided that mitigation measures for water resources and soils outlined in this document are implemented.

Razorback Sucker. Suitable habitat for this species is not available on the ARPA. Suitable habitat does exist downstream of the ARPA in the Yampa and Green Rivers; however, the Proposed Action is not expected to affect this habitat provided that mitigation measures for water resources and soils outlined in this document are implemented.

Pallid Sturgeon. Suitable habitat for this species is not available on the ARPA. The pallid sturgeon is present in the Platte River, a tributary to the Missouri River, located downstream from a portion of the ARPA; however, the Proposed Action is not expected to affect this habitat provided that mitigation measures for water resources and soils outlined in this document are implemented.

The following sensitive species have the potential to occur on the project area, however, the species have not been found within the ARPA. If populations are found, mitigation would be applied to avoid disruption of habitat function or of life history requirements. These species should not be impacted by the project: Nelson's milkvetch, Gibben's beardtongue, pale blue-eyed grass, Cedar Rim thistle, long-eared myotis, fringed myotis, spotted bat, Townsend's big-eared bat, pygmy rabbit, swift fox, trumpeter swan, Yellow-billed cuckoo (east of continental divide) Species which may be affected, as well as fish species are discussed below.

<u>**White-tailed Prairie Dog.**</u> There are currently 295 white-tailed prairie dog colonies, covering 6300 acres, mapped within the ARPA. The BLM requires that development avoid prairie dog colonies whenever possible. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance of some portions of these prairie

dog colonies. Direct impacts to prairie dogs, in the form of lost burrows and foraging habitat, would be avoided and are not expected to exceed the impact significance criteria.

Wyoming Pocket Gopher. Based on the known distribution of the species and the availability of suitable habitat, Wyoming pocket-gophers likely occur in the ARPA. If populations are found, mitigation would be developed to protect them. Therefore, impacts are not expected to exceed the impact significance criteria.

White-faced Ibis. White-faced ibis colonies are always associated with shallow water habitats (Erwin 1983). The Proposed Action is not expected to exceed the significance criteria because development would not occur within 500 feet of riparian and wetland habitats.

Northern Goshawk. In Wyoming, goshawks are found in lodgepole pine and aspen habitat (WGFD 1999). Northern goshawks are known to occur adjacent to the ARPA (WGFD 2003a). Two active goshawk nests were documented outside the eastern edge of the ARPA in the mid to late 1980s. With the implementation of mitigation measures for raptor nests (Appendix E); implementation of the Proposed Action would not significantly impact the northern goshawk.

Ferruginous Hawk. Ferruginous hawks are known to occur and nest on the ARPA. The primary potential impact to ferruginous hawks from project activities is disturbance during nesting, which could result in reproductive failure. This potential impact would be mitigated by implementing measures in Appendix E. Development of the Proposed Action would not significantly impact the ferruginous hawk.

Peregrine Falcon. An available prey base of shorebirds, waterfowl, and/or small-to-medium sized terrestrial birds usually occurs within ten miles of the nest site. Peregrine falcons may migrate through the project area and have been observed on the ARPA (WGFD 2003a), but nesting on or near the project area is unlikely due to the lack of cliffs high enough to provide suitable nesting habitat. If nesting peregrine falcons are found on the ARPA, then all appropriate mitigation measures for raptors would be implemented to prevent or minimize impacts.

Greater Sage-grouse. See Section 4.7.3.1.3.

Columbian Sharp-tailed Grouse. See Section 4.7.3.1.3.

Mountain Plover. A portion of the potential mountain plover nesting habitat may be disturbed with implementation of the Proposed Action. Impacts to mountain plovers would be minimized by avoiding construction activities in suitable plover nesting habitat during the nesting period from April 10-July 10. Mountain plover tend to use the same nesting areas from year to year, but the exact nest locations change. Mountain plovers often nest near roads, feed on or near roads, and use roads as travel corridors (USDI-FWS 1999), all of which make the species susceptible to being killed by vehicles. Thus, the Operators would be required to inform employees about the potential for roadside and roadway use by this species. The BLM may also identify mountain plover "occupied habitat areas". If these areas were proposed for disturbance, additional mitigation measure(s) would be required to reduce impacts. Given the implementation of mitigation measures in Appendix E, mountain plovers are not expected to be significantly impacted.

Long-billed Curlew. In Wyoming, it is an uncommon summer resident but may be locally common in suitable habitat (WGFD 1999). The long-billed curlew is a BLM sensitive species

throughout all of Wyoming. There have been three recorded observations of this species approximately two miles northeast of the ARPA and one recorded observation in the east-central portion of the ARPA (WGFD 2003a). The long-billed curlew is not expected to nest on the project area due to lack of habitat, and no significant impacts to this species are expected with implementation of the Proposed Action.

Burrowing Owl. Burrowing owls are known to occur on the ARPA (WGFD 2003a). One active burrowing owl nest was located on the ARPA in 2002. Surveys for this species should be conducted prior to construction in prairie dog colonies during the owl breeding/nesting season. If nesting owls are found, the same measures used for other raptor species (Appendix E) would be applied. Given these precautionary measures, no significant impacts to this species are expected to result from the implementation of the Proposed Action.

Sagebrush obligate song birds. The sage thrasher, loggerhead shrike, Brewer's sparrow, sage sparrow, and the Baird's sparrow are found in the ARPA (WGFD 2003a). The Proposed Action activities may displace birds to lower quality habitats, which may lead to a reduction in reproduction rates or an increase in predation. The magnitude of direct and indirect habitat loss (Section 4.7.3), and continued human presence would exceed the significance criteria.

Northern Leopard Frog. Sightings have been documented in all counties of Wyoming and this species has a high probability of occurring in areas of the ARPA having perennial water (WYNDD 2003). Provided that measures are taken to avoid disturbance and/or contamination of perennial water sources (see water and soil sections of this document), no significant impacts to this species are expected from implementation of the Proposed Action.

Sensitive Fish Species

Research conducted during the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed, including the ARPA, found the two most consistent habitat associations among sub-adult and adult roundtail chubs, bluehead suckers, and flannelmouth suckers to be positive associations with both rock substrates and deep pools (Figures 4-1 and 4-2; Bower 2005). Under the Proposed Action, the primary impacts to these two habitat features are (1) sedimentation from new construction and project-related land disturbance resulting in decreased availability of rock substrates, and (2) alteration of local hydrologic conditions by new road construction that could lead to sedimentation and channel adjustments resulting in a loss of deep pool habitats. Additionally, fragmentation of aquatic habitats, if any project-related road crossings of Muddy Creek are constructed, could limit access to required habitats or block fish migration. Also, though no discharges of produced water to the Little Snake River drainage are planned for the project, because of their limited distribution in Wyoming and range-wide, accidental releases of produced waters or other toxic materials to Muddy Creek would pose a potential risk to sensitive fish populations.

The impact of new roads and other facilities on fish habitats can be divided into three categories: construction, presence, and urbanization (Angermeyer et al. 2004). During the construction phase, prior to interim reclamation, erosion of soils exposed during earth-moving activities accelerates fine-sediment loading in stream channels. Though the biological effects of sedimentation include a variety of ecological interactions (Waters 1995), sedimentation can act to shift habitat structure such as channel depth, pool-to-riffle ratio, percent fines in substrates, and cover availability (Angermeyer et al. 2004). This sediment can extend miles downstream of the construction site and persist in stream channels for years (Angermeyer et al. 2004).

During the presence phase, impacts are primarily associated with the interception of shallow groundwater flow paths by roads. Water is frequently diverted along the roadway and routed to surface-water drainage networks at drainage crossings. This can, in turn, alter the timing, routing, and magnitude of runoff, triggering geomorphic adjustments through erosion by channel incision, new gully or channel head formation, or slumping and debris flows (Figure 4-3; see review in Trombulak and Frissel 2000). Channel incision occurs when the base elevation of the stream channel adjusts to account for an alteration of geomorphic parameters such as sediment supply, flow volume, or channel roughness (e.g., riparian vegetation). Channel incision has been shown to simplify channel geometry and result in the loss of pool habitats (Shields et al. 1994).

In the case of the proposed action, the effects of urbanization can be thought to include the detrimental effects of exotic species introductions and increased human presence within the ARPA. Roads provide dispersal mechanisms for a variety of exotic upland and riparian plant species. Of particular concern is the spread of tamarisk (*Tamarix* spp., also known as salt cedar) within the upper Muddy Creek watershed. This exotic species has been shown to displace native riparian vegetation while consuming a greater volume of water, resulting in reduced water tables and suitability of aquatic habitats (Graf 1978). Tamarisk is currently known to exist in portions of the ARPA and its spread is likely as a result of dispersal via new road construction and utilization. Increased human uses of the area are also likely to increase the probability of unsanctioned, illegal, and unintentional introductions of exotic fishes and other aquatic organisms. These introductions have been cited as one of the major threats to freshwater biodiversity (Allen and Flecker 1993) and warrant careful consideration given the detrimental effects of exotic fishes on native Colorado River Basin fishes present within the upper Muddy Creek watershed.

Stream fishes require habitats for spawning, feeding, rearing, and refuge. The spatial heterogeneity and connectivity of the stream system can necessitate the movement of fishes among these habitats in order to complete their life cycles (Schlosser 1995). Interruption of movement among required habitats by road crossings can have demographic effects, decreasing population viability (Trombulak and Frissel 2000; Gibson et al. 2005). The distributions of the three target species during the summer and fall of 2003 suggest several potential implications of habitat fragmentation in regards to access to refuge habitats and subsequent ability to recolonize adjacent reaches (Bower 2005). Additionally, movements of the three species observed during 2005 suggests that required habitats exist in spatially distinct portions of the watershed, thus requiring movement of individuals in order to complete their life history requirements (Bobby Compton, University of Wyoming, personal communication).

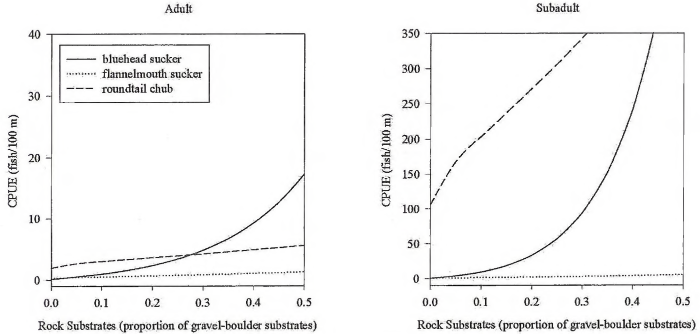


Figure 4-1. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of the prevalence of rock substrates at the reach scale from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species.

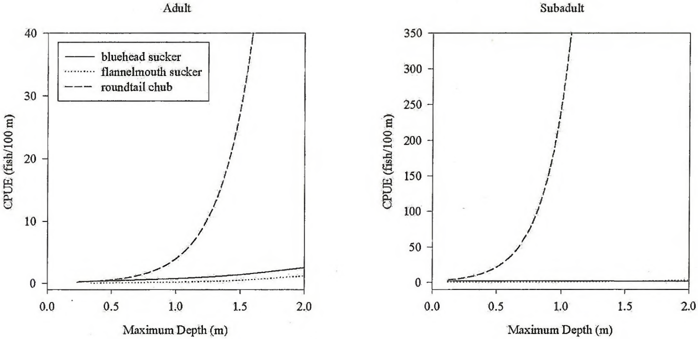


Figure 4-2. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of maximum channel unit depth from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species above minimum depth thresholds.

Figure 4-3. Example of erosion resulting from concentration of surface runoff at drainage crossings.

Eighty-acre spacing of coalbed methane well locations under the proposed action would result in a road density of 7.1 mi/mi^2 within the Upper Muddy Creek/Grizzly Special Management Area. This includes new road construction (0.5 mi/well location) as well as 100 miles of existing road. Additionally, crossings of Muddy Creek are anticipated as a result of the proposed action, though the number and specific location of these crossings has not yet been determined.

Research within the Little Robbers Gulch drainage (bordering the ARPA on its western edge) has demonstrated the effects of roads, natural gas drillpads, and pipelines on sediment production and runoff (Wollmer 1994). This work examined the effect of road densities of 2 mi/mi^2, including associated well pad and pipeline facilities, on local sediment production and runoff. A net increase of 1% in local sediment production and 0.3% in local runoff was found when compared to unaltered rangeland sites. Though this work helps to identify the potentially limited extent of local erosion caused by roads, the study did not address the effects of flow interception which can lead to altered runoff timing, routes, and magnitudes. It is these hydrologic alterations that are most likely to result in geomorphic adjustments through erosion, causing sedimentation or loss of habitat features such as deep pools.

Roundtail Chub. Based on the impacts of new roads and other facilities on the habitat features found to be important to roundtail chubs within the upper Muddy Creek watershed as well as the effects of habitat fragmentation on the ability of roundtail chubs to access required habitats, the proposed action would significantly impact the habitat of this species within the ARPA, and may preclude improvement of their status as prescribed in the *Range-wide Conservation Agreement for Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chubs.*

Bluehead Sucker. Based on the impacts of new roads and other facilities on the habitat features found to be important to bluehead suckers within the upper Muddy Creek watershed as well as the effects of habitat fragmentation on the ability of bluehead suckers to access required habitats, the proposed action would significantly impact the habitat of this species within the ARPA, and may preclude improvement of their status as prescribed in the *Range-wide Conservation Agreement for Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chubs.*

Flannelmouth Sucker. Based on the impacts of new roads and other facilities on the habitat features found to be important to flannelmouth suckers within the upper Muddy Creek watershed as well as the effects of habitat fragmentation on the ability of flannelmouth suckers to access required habitats, the proposed action would significantly impact the habitat of this species within the ARPA, and may preclude improvement of their status as prescribed in the *Range-wide Conservation Agreement for Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chubs.*

Colorado River Cutthroat Trout. Given the absence of Colorado River cutthroat trout from the ARPA and portions of Muddy Creek downstream of the ARPA, the proposed action is not likely to significantly impact the habitat of this species.

4.8.3.3 Alternative A - No Action

There would be no additional disturbance as a result of this alternative.

4.8.3.4 Alternative B

The temporal development involves the same number and spacing of wells to be drilled as in the proposed action. However, the principle difference would be that the majority of development would occur in three phases with the center portion of the project area (Doty Mountain Pod, Sundog/Cow Creek POD and Blue Sky Pod) being developed first over a 5 to 6 year period. The entire project area would still be developed over a twenty year period. The initial phase would involve up to half of the total wells proposed. Development would then be shifted to the second phase in the northern portion and the third phase in the southern portion of the project area. There would be continued drilling within previously analyzed PODs under the existing interim drilling plan concurrently with development of the initial phase. However, this drilling and facility development would be limited. In terms of disturbance to wildlife and their habitats, this phased approach would be beneficial by temporarily delaying fragmentation of habitat, providing "safe-haven" areas in two thirds of the project area during the development phases. This would be more beneficial to those species requiring large blocks of undisturbed habitat.

Under this alterative all impacts on the species would remain the same as the Proposed Action unless addressed below.

Wildlife Species

Impacts to wildlife species under this alternative would be same as the proposed action, however, species may benefit temporarily as the development is phased in over the LOP. The impacts from the production phase once construction is completed would be the same as the proposed action.

Fish

Similar to the proposed action, eighty-acre spacing of coalbed methane well locations under the proposed action would result in a road density of 7.1 mi/mi^2 within the Upper Muddy Creek/Grizzly Special Management Area. This includes new road construction (0.5 mi/well location) as well as 100 miles of existing road. Resulting impacts to the habitats of sensitive fishes would be similar to those disclosed within the proposed action.

Muddy Creek represents a boundary between the first and second phases of development under Alternative B. Given this boundary, there may be a decreased desire to construct crossings of Muddy Creek as development proceeds within each of the phases. The avoidance of road crossings of Muddy Creek would eliminate resulting fish habitat fragmentation and reduce the likelihood of exotic species introductions.

Roundtail Chub. Based on the impacts of new roads and other facilities on the habitat features found to be important to roundtail chubs within the upper Muddy Creek watershed, Alternative B would significantly impact the habitat of this species within the ARPA. The avoidance of road crossings of Muddy Creek would eliminate resulting fish habitat fragmentation and reduce the likelihood of exotic species introductions.

Bluehead Sucker. Based on the impacts of new roads and other facilities on the habitat features found to be important to bluehead suckers within the upper Muddy Creek watershed, Alternative B would significantly impact the habitat of this species within the ARPA. The avoidance of road crossings of Muddy Creek would eliminate resulting fish habitat fragmentation and reduce the likelihood of exotic species introductions.

Flannelmouth Sucker. Based on the impacts of new roads and other facilities on the habitat features found to be important to flannelmouth suckers within the upper Muddy Creek watershed, Alternative B would significantly impact the habitat of this species within the ARPA. The avoidance of road crossings of Muddy Creek would eliminate resulting fish habitat fragmentation and reduce the likelihood of exotic species introductions.

Colorado River Cutthroat Trout. Given the absence of Colorado River cutthroat trout from the ARPA and portions of Muddy Creek downstream of the ARPA, Alternative B is not likely to significantly impact the habitat of this species.

4.8.3.5 Alternative C

The Spatial Development alternative would proceed with development across the ARPA similar to the Proposed Action, but surface disturbance would be reduced in areas with critical/sensitive resource concerns. These areas would have additional protective measures (Appendix L) beyond what is already required (See Appendix E and mitigation measures from other resources). Examples of some of these sensitive sites are steep slopes, soils with high runoff potential, big game crucial winter range, greater sage-grouse nesting and brood rearing habitat,

class III visual areas, and juniper/true mountain mahogany plant communities. Because of these sensitive issues, there would be fewer pad locations per section on public lands. This would reduce the total acres disturbed to 64 percent less than the proposed action. Long-term disturbance would be reduced by approximately 77 percent less than the proposed action. There would be less than 20 acres of pre-reclamation and 5 acres of post-reclamation surface disturbance with a maximum of 4 pads per section in grouse nesting and brood rearing habitat. This would directly reduce habitat fragmentation and human presence for other associated sagebrush obligate species. Soil mitigation, restricting surface disturbance on high runoff potential soils, would also indirectly protect over half of the saltbush steppe habitat within the ARPA. This would benefit species such as white-tailed prairie dog, mountain plover, and burrowing owl. Direct disturbance would be reduced by 64%, reducing impacts to all BLM sensitive species. Impacts would not exceed the significance criteria for sagebrush obligate species under this alternative.

Fish

Development protection measures within the Upper Muddy Creek Watershed/Grizzly SMA would benefit sensitive fishes by limiting the alteration of local hydrologic conditions that create and maintain habitat features of importance to sensitive fishes. Two of these habitat features, rock substrates and deep pool habitats, have been shown to be of importance to sensitive fishes (Bower 2005) and are though to be susceptible to loss or decreased suitability as a result of hydrologic alteration from road construction. Maintenance of existing road densities, through the utilization of existing road paths, as well as incorporation of appropriate road designs, such as low-impact road designs on slopes of less than 8 percent, would result in a net decrease in erosion from the existing road network. Particularly problematic road paths that are causing accelerated erosion would be identified within transportation planning efforts. By reclaiming these problematic road paths, additional road lengths would be available for new road construction when lease holdings could not be accessed along existing paths, without resulting in a net increase in road density or erosion.

Additional special protective measures within the Upper Muddy Creek Watershed/Grizzly SMA would preclude the fragmentation of fish habitats by road crossings, thus ensuring that access among the diverse habitats required by sensitive fishes is maintained. These measures would also limit the potential spread of exotic species that often have detrimental direct or indirect impacts on sensitive fishes and their habitats.

Roundtail Chub. Given the implementation of special protective measures identified for the Upper Muddy Creek Watershed/Grizzly SMA, the Alternative C would not significantly impact the habitat of this species within the ARPA.

Bluehead Sucker. Given the implementation of special protective measures identified for the Upper Muddy Creek Watershed/Grizzly SMA, Alternative C would not significantly impact the habitat of this species within the ARPA.

Flannelmouth Sucker. Given the implementation of special protective measures identified for the Upper Muddy Creek Watershed/Grizzly SMA, Alternative C would not significantly impact the habitat of this species within the ARPA.

Colorado River Cutthroat Trout. Given the absence of Colorado River cutthroat trout from the ARPA and portions of Muddy Creek downstream of the ARPA, the Alternative C is not likely to significantly impact the habitat of this species.

4.8.4 Impact Summary

4.8.4.1 Proposed Action

T&E

Implementation of the Proposed Action would result in direct loss of habitat from surface disturbance associated with the construction of well sites, related facilities, access roads, and pipelines. In addition, some wildlife species would be indirectly impacted by displacement from habitats in the vicinity of the project area due to the presence of human activities associated with the construction and operation of wells. Small portions of potential black-footed ferret habitat may be disturbed. The potential for collisions between bald eagles and motor vehicles would also increase due to the construction of new roads and increased traffic levels on existing roads. The primary source of potential risks to the fish species is increase in suspended sediments and sedimentation from land disturbance from project activities. The intensity of these impacts may decrease with the completion of the construction phase and with the onset of reclamation efforts on disturbed areas.

None of the threatened and endangered species found downstream of the ARPA within the Colorado River system are known to occur in the ARPA, therefore there would be no direct impacts to these species. However, water depletion as a result of project development, even though minimal, could indirectly impact these species. Implementation of all mitigation measures for water and soils would help reduce other potential impacts. No produced water from the ARPA would be discharged to the Little Snake River drainage; therefore, produced water discharges do not pose a risk to these species. Accidental releases of produced waters or other materials could occur. However, these materials would become highly diluted before they would reach any downstream waters where these species occur; consequently, the potential risks from such occurrences are negligible. Any water depletion within the Colorado River system results in a "may affect, likely to adversely affect" determination for threatened and endangered species found in and along this river. Therefore, BLM would initiate formal consultation with FWS for those species. If any threatened or endangered fish species are identified within the ARPA, the BLM would consult with the FWS and develop a protection plan for the fish.

Sensitive Species

With the implementation of the Proposed Action, direct loss of habitat would result from surface disturbance associated with the construction of well sites and related access roads and pipelines. Small portions of potential habitat for several sensitive species may be disturbed. The intensity of these impacts would decrease with the completion of the construction phase and with the onset of reclamation efforts on many of the disturbed areas. The application of prescribed avoidance, monitoring (Wildlife Monitoring/Protection Plan, Appendix E) and mitigation measures would reduce the impact potential. Impacts would still exceed the significance criteria for sagebrush obligate species. Alteration of fish habitat suitability would result in significant impacts to sensitive fishes.

4.8.4.2 Alternative B

The impacts to T&E species would be the same as under the Proposed Action.

Overall impacts to BLM sensitive species would be very similar to the proposed action. In terms of disturbance to wildlife and their habitats, this phased approach would be beneficial by temporarily delaying fragmentation of habitat, providing "safe-haven" areas in two thirds of the project area during the development phases. This would be more beneficial to those species requiring large blocks of undisturbed habitat. Impacts would still exceed the significance criteria for sagebrush obligate species. Alteration of fish habitat suitability would result in significant impacts to sensitive fishes.

4.8.4.3 Alternative C

Overall impacts to special status species would be very similar to the proposed action. Direct disturbance would be reduced by 64%, reducing potential impacts to all special status species. Impacts would not exceed the significance criteria for sagebrush obligate species under this alternative. Development protection measures applied to the Upper Muddy Creek Watershed/Grizzly SMA would help to maintain the suitability of habitats for sensitive fishes.

4.8.5 Additional Mitigation Measures

4.8.5.1 Proposed Action

There are no additional mitigation measures identified for T&E species or BLM sensitive species except if identified mountain plover "occupied habitat areas" are proposed to be disturbed:

- Surface disturbance would occur outside identified occupied habitat for mountain plovers where feasible.

- Within ½ mile of the identified mountain plover occupied habitat area; speed limits would be posted at 25 mph on resource roads and 35 mph on local roads during the brood rearing period (June 1 - July 10).

- The access road would be realigned to avoid the identified mountain plover occupied habitat area.

- To protect mountain plover in occupied habitat, traffic would be minimized from June 1 - July 10 by car-pooling and organizing work activities to minimize trips on roads through the mountain plover occupied habitat area.

- To protect mountain plover in occupied habitat, fences, storage tanks, and other elevated structures would be either constructed as low as possible and/or would incorporate perch-inhibitors into their design.

- To minimize destruction of nests and disturbance to breeding mountain plovers, no ground-disturbing activities would occur from April 10 - July 10 unless surveys consistent with the Plover Guidelines or other FWS approved method find that no plovers are nesting in the area.

- A plugged and abandoned well within ½ mile of the identified mountain plover occupied habitat area would be identified with a marker 4 feet tall with a perch inhibitor on the top of the marker.

4.8.5.2 Alternative B

There are no additional mitigation measures identified.

4.8.5.3 Alternative C

Additional mitigation proposed:

- Low impact road design for resource roads (roads into individual pads) on slopes < 5%, if road can be built with no side slopes. This would include ditch-witching utilities within the ROW, brush beating, some type of fabric or matting and gravel.
- Improve road surface on newly constructed or improved local and collector roads with 95% compaction on the road base and non-chlorine dust abatement product or suitable alternative treatment each year
- Reduce pad density to 4 locations per section and the associated infrastructure and limit initial disturbance (i.e. short-term) total to < 20 acres per section in CWR, grouse nesting and brood-rearing habitat, soils with high runoff potential, vegetation communities on >8% slopes
- Avoid surface disturbances within aspen, juniper woodland, True mountain mahogany, and serviceberry communities
- Limit surface disturbances within the silver sagebrush/bitterbrush vegetation community
- No surface disturbance within identified severe winter relief habitat for greater sage-grouse
- No surface disturbance within identified winter habitat for Columbian sharp-tailed grouse
- Road density would be targeted for less than 3 miles/mile^2, transportation and well access roads would utilize existing road paths where feasible, no new road crossings of Muddy Creek, use only non-chlorine deicing and dust control agents, convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement, and no surface disturbances within aspen, juniper-woodland, true mountain mahogany, and serviceberry communities within the Muddy Creek SMA
- Road density would be targeted for less than 3 miles/mile^2, convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement, and no surface disturbances within aspen, true mountain mahogany, and serviceberry communities within the Cow Butte/Wild Cow SMA
- Net reduction in road density to less than 3 miles/mile^2, transportation and well access roads would utilize existing road paths where feasible, use only non-chlorine deicing and dust control agents, convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement, no surface disturbance within the 18 acres surrounding JO Ranch Headquarters, and limit surface disturbances within the silver sagebrush/bitterbrush community to < 20 acres/mi^2 within the Sand Hills SMA

4.8.6 Residual Impacts

4.8.6.1 Proposed Action

Standard mitigation measures would not completely alleviate the magnitude of habitat loss and continued human presence during the production phase of the project on nesting and foraging habitats for sagebrush obligate species.

Standard mitigation measures would not completely alleviate the long term loss of shrubs, nor the indirect impacts on habitat, such as dust, noise, and continued human presence during the drilling and production phase in special status species' habitat.

4.8.6.2 Alternative B

Similar to the proposed action, with the same number of pad locations and spacing, standard mitigation measures would not completely alleviate the magnitude of habitat loss and continued human presence during the production phase of the project on nesting and foraging habitats for sagebrush obligate species.

Similar to the proposed action, with the same number of pad locations and spacing, standard mitigation measures would not completely alleviate the long term loss of shrubs, nor the indirect impacts on habitat, such as dust, noise, and continued human presence during the drilling and production phase in special status species' habitat.

4.8.6.3 Alternative C

Although the additional mitigation would reduce the long term loss of shrubs, the indirect impacts on habitat, such as dust, noise, and continued human presence during the drilling and production phase, disturbance to special status species' habitat would still occur.

4.9 RECREATION

4.9.1 Introduction

This section addresses the potential impacts of the Proposed Action and Alternatives to recreational resources in the ARPA. The analysis focuses on the principal form of recreation within the ARPA, which is big game hunting, and considers both direct and indirect impacts to recreation resources.

4.9.1.1 Analysis Approach

The ARPA contains no developed recreation sites. Off-highway vehicle (OHV) use is limited to existing roads and two-tracks. Dispersed recreation in the ARPA occurs primarily on BLM land and consists largely of hunting by residents and visitors from outside the region. Camping and OHV use within the ARPA occur most often in conjunction with hunting. There is some seasonal pleasure driving and snow machine use, which often incorporate wildlife viewing as a significant reason for visiting the area. The ARPA contains two ACECs – Sand Hills ACEC and Jep Canyon ACEC – which merit intensive management of surface-disturbing activities for wildlife habitat (USDI-BLM 1990, 2003).

The health and abundance of wildlife populations directly affect the quality of hunting in the ARPA. When wildlife populations fluctuate, so do wildlife-based recreational opportunities. To determine impacts to hunting, the recreation analysis relies on the analysis of impacts to big game wildlife in the ARPA. The narrative and maps presented in Section 3.7 (Wildlife) were evaluated for their potential effect on hunting because of a loss of carrying capacity or the displacement of game.

Impacts to visual resources in the ARPA, identified in Section 4.10, also were considered for effects on recreation. Visual resources influence the character of outdoor opportunities by affecting the recreation setting, as do other effects of gas development such as noise, dust and traffic on recreational access routes.

4.9.2 Impact Significance Criteria

The recreation analysis evaluates impacts according to the management objectives established for the Great Divide Resource Area RMP. BLM management objectives for recreation resources are to ensure continued availability of outdoor recreational opportunities, while meeting legal requirements for the health and safety of visitors and mitigating conflicts with other resources.

The main concern for the recreation analysis is displacement of existing recreational use by the Proposed Action and Alternatives. Impacts to recreation would be significant if the Proposed Action or Alternatives would cause displacement of hunting, wildlife viewing, and driving for pleasure from the ARPA when no other comparable area nearby could reasonably provide substitute opportunities.

4.9.3 Direct and Indirect Impacts

The Proposed Action and Alternatives would potentially have both direct and indirect impacts to recreation. Direct impacts to recreation resources occur because of the physical disturbance of vegetation from the construction of facilities, the visual impacts of facilities and activities, and from the noise, traffic and visual distraction of human activity.

Examples of direct impacts include the removal of wildlife habitat that may affect game populations and the intrusion of gas facilities on a natural appearing landscape. Indirect effects to recreation resources include changes to recreation use and experiences on lands near directly impacted recreation resources. Examples are disturbances of nearby recreation settings by traffic, noise and landscape changes associated with gas facilities and related activity that would intensify visitation at undeveloped areas nearby.

Most effects to recreation from the Proposed Action and Alternatives would be considered adverse because they tend to decrease recreation opportunities and the appeal of the setting for most recreation participants. New roads associated with development may be considered beneficial in that they provide increased access for activities such as hunting but adverse in that the associated increase in activity of development would displace wildlife. Hence new roads do not benefit hunting if game is displaced. Initial increases in access might increase success rates early in the life of the project, but as development progresses, and game is displaced, success rates would be expected to decline with the size of the herd remaining in the project area. The opportunity to pursue game on foot is diminished when an abundance of roads provide access to road hunters that could scare game from the area.

Indirect impacts to recreation also can occur from population growth associated with the project's workforce. This factor was considered but not pursued further in the analysis of the Proposed Action and Alternatives because the project is unlikely to cause significant population effects, as described in Section 4.12 (Socioeconomics). Impacts to recreation from potential residential development in the future also are described in Chapter 5 (Cumulative Impacts Analysis).

Impacts Analysis

The principal recreation impact likely to be associated with the Proposed Action and Alternatives is the change in big game hunting opportunities because of habitat loss and wildlife displacement. The underlying effects upon wildlife habitat and behavior are analyzed in Section 4.7 (Wildlife). Changes to the landscape, analyzed in Section 4.10 (Visual Resources), also may affect hunters who value a natural setting as part of their experience and pleasure drivers who visit the ARPA to view the scenery and watch wildlife. These impacts would occur as the direct and indirect results of a higher density and wider distribution of gas development within the ARPA compared to existing conditions.

4.9.3.1 Proposed Action

As described in detail in Chapter 2, a total of 2,000 new natural gas wells would be drilled and developed under this alternative during the next 20 years with an expected LOP of 30-50 years. Well placement within the ARPA is not known at this time, but it is assumed that development would likely be concentrated within or near existing pods, although some wells also would be drilled in outlying areas where development currently does not exist.

Impacts to Hunting

The big game species potentially affected by the Proposed Action are mule deer, elk and pronghorn antelope. The proposed level of development would disturb approximately 15,803 acres of wildlife habitat over 20 years, but the practice of beginning reclamation when an individual facility is completed, as intended by the operator, would mean that the total un-reclaimed area in the ARPA would always be less than 15,803 acres at any one time during the development phase. After the completion of development, successful interim reclamation would reduce long-term disturbance and direct loss of habitat to a total of 6,241 acres.

In addition to the direct loss of habitat due to construction of well pads and associated roads, pipelines and utilities, disturbance from human activity and traffic would lower the utilization of habitat immediately adjacent to developed areas and cause wildlife displacement from an area larger than the actual disturbed sites. As noted in Section 4.7 (Wildlife), this displacement effect has the potential to have a great impact on wildlife not only due to displacement, but also due to wildlife concentration beyond carrying capacity in alternative habitats.

The extent of wildlife displacement is impossible to predict for most species. After initial avoidance some species such as deer and pronghorn may acclimate to the activity and begin to re-occupy the disturbed areas. Acclimation and re-occupation would be expected to occur following construction and drilling when the project moves into the production phases where less noise and human activity would take place. Despite acclimation and re-occupation, it is generally assumed that overall the increased human footprint on a previously lightly developed area is detrimental to big game species.

To the extent that displacement of big game does occur in connection with the Proposed Action, adverse impacts to hunting would occur in the ARPA. The impact would be borne primarily by local and regional hunters, especially local hunters for whom the benefits of the ARPA would be diminished as a convenient and economical place to hunt for sport and for game meat for the table. The impact also would be borne by commercial outfitters permitted to use the ARPA (see table 3.39). Increased development in the ARPA—with its potential to displace big game and its effect on the recreation setting—would reduce the appeal of the project area for a commercial clientele whose values include a successful harvest in an attractive recreational setting.

Impacts to the Recreation Setting

For many hunters and other outdoor recreationists, a natural setting is critical to the quality of the recreation experience. In the ARPA, the Proposed Action and Action Alternatives would potentially affect the recreation setting because of visual impacts and because of traffic and noise impacts.

As would be seen in Section 4.10, Impacts to Visual Resources, concludes that the Proposed Action and Action Alternatives would have a high, adverse impact on the natural appearance of the landscape. This level of degradation of the scenery would potentially affect hunters and other recreation visitors to the ARPA.

Research has found that hunters participate in this activity for many reasons. Though hunting success is the predominant reason, enjoyment of the outdoors and the environment has a role for many hunters (Manning 1986). Therefore, the visual quality of the setting would likely be important to many hunters in the ARPA, and degradation of the scenery in the project area would potentially diminish their enjoyment and the satisfaction of the hunt.

For pleasure drivers and wildlife viewers, natural scenery and productive wildlife habitats are an essential part of the activity. Therefore, recreation visitors who visit the ARPA to drive for pleasure or view wildlife would likely be very sensitive to changes in visual quality, and for these visitors, adverse impacts to visual quality in the project area would likely diminish their enjoyment of the outdoor experience.

For hunters, wildlife viewers and pleasure drivers, industrial traffic on roads in the ARPA would potentially detract from the recreational character of the setting in the ARPA. The operator is committed to posting appropriate warning signs, implementing safety training for the operators of project vehicles and equipment, and requiring project vehicles to adhere to low speed limits (see Section 2.13). These project management practices would potentially limit conflicts between project activity and recreation use in the ARPA. However, some level of conflict with the expectations of recreationists is unavoidable, particularly during drilling and field development activities. The risk of traffic accidents is significantly increased by vehicles associated with development and production in the ARPA.

Noise levels associated with drilling, field development, and operations activities may temporarily exceed threshold EPA average noise levels at specific locations within the ARPA, as would be noted in Section 4.15, Noise. This would directly detract from the relative silence of undisturbed country customarily sought by recreational visitors engaged in hunting, wildlife observation, and sightseeing. Noise impacts due to drilling, field development, and traffic may be unavoidable, at least during the drilling and development phases, after which much of the noise would abate. However, noise associated with compression and individual well pumps would be long term in duration and would potentially displace recreation to other areas.

Impacts to hydrologic systems and soil stabilizing vegetation would impact the recreation experience by altering the undeveloped setting present in most of the ARPA. The proliferation of opportunistic weeds on disturbed soils would further alter the setting and inhibit the success of reclamation.

The duration of the effects would be for the life of the project—which may affect more than one generation of recreation users—but the intensity of the effects would be lower after drilling and construction ends. The Proposed Action would likely displace some dispersed recreation use from the ARPA to areas for hunting and wildlife viewing that are farther away and are themselves likely to be under increasing pressure for development.

As noted in Chapter 3, there are no recreational visitation counts for the ARPA, but overall use is believed to be low, except during and just prior to hunting season which occurs primarily in the fall (USDI-BLM 2000). Low visitation during the rest of the year is due to low population densities in proximity to the area and the historically seasonal nature of the road network. Snow drifts in winter and any rains the rest of the year have, in the past, made most of the roads intermittently impassable.

Visitation to the ARPA may increase in the future because of recent improvements in surfacing on BLM and county roads. New roads developed in the ARPA to support gas development may also encourage use by opening new areas to access. With increased use over time, the impact of the Proposed Action may be higher. Another factor expected to promote visitation to the area is the stabilization and interpretation of the JO Ranch that was recently acquired by BLM near the Sand Hills. The Continental Divide National Scenic Trail (CDNST) is not likely to increase visitation to the project area, despite its being within 3 miles of the northeastern boundary of the ARPA.

In conclusion, the adverse impacts to the predominant recreation activities in the ARPA—hunting, pleasure driving and wildlife viewing—would be significant. The Proposed Action would diminish the wildlife presence, degrade scenery, and introduce traffic and noise. These effects would likely make recreation in the project area less desirable.

4.9.3.2 Alternative A – No Action

Under the No Action Alternative, the Proposed Action would not be approved. The ARPA's recreation experience would continue to be affected by existing facilities and interim drilling, but no new impacts to recreation and hunting would be introduced by the No Action Alternative.

4.9.3.3 Alternative B

Under Alternative B (as under the Proposed Action) a total of 2,000 new gas wells would be drilled and developed during the next 20 years with an expected LOP of 30-50 years. However, development would potentially occur in three zones by developing only two or three adjacent pods at a time. Each zone would take 6 to 7 years to develop.

Short term impacts to recreation occurring under Alternative B would be qualitatively the same as under the Proposed Action. However, the zoned approach would reduce short-term impacts occurring simultaneously during the project's development phase. While one phase is being developed, the other zones would also see activity, but not to the same degree as the zone under development. How many wells would be drilled in the other zones concurrently has not

been determined, but it would still generate traffic on primary roads, dust, traffic hazards and noise in areas outside the zone of concentrated development.

Thus, even though development is concentrated in one zone at a time, some development and disturbance would still be occurring in the other zones, so the wildlife and recreation associated with it would still likely be displaced from areas under development, making the impact to hunting and wildlife viewing significant in the long term. However, the reduced level of simultaneous development in the other zones would temporarily leave some areas undisturbed, which would allow hunters and recreationists limited, but continued opportunities to use portions of the ARPA.

After a zone is completed and interim reclamation occurs, wildlife may return to the area to some degree, but continued production operations would likely prevent normal wildlife activity and concentrations until after effective final reclamation has restored vegetation.

Long-term impacts to recreation would be the same under Alternative B as under the Proposed Action. Development would still continue for approximately 20 years. However, instead of the area of maximum surface disturbance moving generally outward concentrically from all of the existing interim development pods, only two or three adjacent pods would experience simultaneous concentrated development in the form of a zone.

4.9.3.4 Alternative C

Under Alternative C, as under the Proposed Action, a total of 2,000 new natural gas wells would be drilled and developed under this alternative during the next 20 years with an expected LOP of 30-50 years. However, development would potentially be constrained in areas that have critical resource concerns, such as fisheries, hydrology, soils and wildlife.

Some of the development protection measures included in Alternative C would reduce impacts to recreation. Limitations on surface disturbance in slopes over 8%, vegetation communities with high wildlife values, rare vegetation communities, proximity to water or wetlands, big game crucial winter range, grouse brood rearing and nesting habitat, silver sagebrush/bitterbrush communities, and soils with high runoff potential would help retain the existing quality of recreation opportunities in the ARPA. Road density limitations for grouse brood rearing and nesting habitat and some SMAs along with requirements for prompt interim reclamation, low impact road designs, careful siting of well pads, roads and facilities, and dust abatement techniques would also contribute to preservation of the recreation setting.

Data from the Wyoming Game and Fish Department (WGFD) random surveys were used to identify the areas of concentration of deer and elk hunter success in the ARPA. These areas are illustrated in Appendix M: Locations of Successful Hunts. As the figure shows, the hunter success is concentrated in five general areas, all of which fall within the boundaries of WGFD game management unit (GMU) 82, one of the most heavily hunted areas in the state. The areas are generally known as The Sand Hills, Deep Gulch and Cow Creek, Wild Cow Creek, Cherokee Creek, and Wild Horse Creek. Development in or adjacent to these areas would be expected to displace big game, and thus big game hunting to other areas where development is not occurring.

Direct loss of habitat due to construction of well pads and associated roads and pipelines, would lead to some wildlife displacement in these areas. Displacement due to habitat loss can be minimized but not avoided. This type of displacement would have an adverse impact to hunting

in the ARPA. This impact would be disproportionate because of the importance of these areas to game herds and thus to hunting.

A second type of impact, the disturbance of individual game animals by human activity and traffic, also would potentially have adverse affects on hunting. The long-term displacement of game herds because of sustained activity and noise is addressed in Section 4.7, Wildlife. Very short-term displacement of individual animals or small groups also would occur as an immediate, direct response to traffic, noise, and human activity. This type of disturbance, which can cause game to avoid an area for the better part of a day or so, is disruptive to hunting. Repeated disturbance of this kind could potentially have an adverse impact on an entire hunting season.

Because hunter success in the ARPA is concentrated in the areas described above, short term disturbance of game by project activity occurring during hunting season would potentially have a disproportionate adverse impact on hunter success and the hunting experience. The adverse impact to the areas of concentrated hunter success would potentially reflect on the hunting experience in affected parts of the ARPA and, perhaps, in the GMU as a whole.

The Cow Butte/Wild Cow and Sand Hills SMAs include some of the most heavily hunted portions of the ARPA. Development protection measures for these SMAs would include limitations tosurface disturbance and road densities, and fence conversions to BLM standards for improved wildlife passage. These and other development protection measures particular to each SMA would help retain the quality of hunting, wildlife viewing and recreation experiences in the ARPA.

The potential for a 64% reduction in surface disturbance and other development protection measures associated with Alternative C would reduce the project's impacts on recreation, but the overall network of facilities associated with 2,000 wells would still have a significant impact on recreation in the ARPA by displacing wildlife, and therefore hunters, wildlife viewers and other recreationists.

4.9.4 Mitigation Measures

The recreation analysis assumes the implementation of mitigations adopted as a result of the analysis of impacts to recreation, wildlife resources and visual resources. There are no relevant operator-committed mitigation measures. The mitigations used may include habitat enhancements in nearby undeveloped areas to compensate for degradation of habitat in the ARPA, and other measures as discussed in Section 4.7 Wildlife, in addition to Best Management Practices (BMPs) applied at the EA level. Minimizing activity during hunting season would probably not be an effective mitigation due to the disturbance of wildlife that normally occurs as a part of hunting activities.

No additional mitigation measures are necessary to specifically address impacts to recreation resources.

4.9.5 Residual Impacts

Residual impacts to recreation resources would exist even after the implementation mitigation measures. The residual impacts to recreation resources are the same as those described above in Section 4.9.3. Impacts to Hunting—and, perhaps to a similar extent, wildlife observation—would occur because habitat would be replaced by well pads, roads, and pipelines.

Displacement also would occur because of human activity, traffic, dust and noise adjacent to developed areas. The effects of these changes on wildlife would lower the quality of hunting and wildlife observation in the ARPA, at least until well drilling ends, and to some extent until final reclamation is complete after the end of the life of the project. During operations, wildlife may adapt to the routine activities associated with a well-field in production. Therefore, some re-occupation of disturbed areas may occur and some of the hunting quality may be restored. However, it is likely that there would be some residual impact to hunting and wildlife observation for the life of the project, which is potentially up to 50 years.

Residual impacts to recreation also would occur because of the impact of a natural gas field on the recreation setting. The reduced visual quality of the area after well-field development would primarily affect recreational sightseeing, which is a sensitive use of the ARPA.

4.10 VISUAL RESOURCES

4.10.1 Introduction

The landscape within the ARPA contains broad areas of grasslands, sagebrush, and tree cover, with the type of vegetative cover depending on the elevation of the surface and on water availability. Existing disturbance from oil and gas development is about 604 acres. This disturbance, about 0.2% of the 270,000 total acres in the ARPA, comprises un-reclaimed area from prior development of well pads, compressor stations, and containment ponds. A small portion of the remainder of the ARPA has been modified by improved and unimproved roads, power lines, constructed ponds, and irrigated cropland.

The issues of concern for visual resources in the ARPA are: 1) whether changes to the landscape from gas development would exceed BLM visual resource management objectives, and 2) whether changes in the visual resources due to gas development would potentially affect other users of the ARPA. The objective of VRM Management Class III is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but ***should not dominate the view of the casual observer***. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

The classification of ARPA lands by visual quality, as defined by the BLM in the RMP, was determined according to the visual resource inventory procedure that is prescribed in BLM's Visual Resource Inventory Manual 8410.

The BLM's visual resource considerations during the siting of oil and gas facilities seek to minimize impacts to the extent possible and to avoid impacts that exceed allowable thresholds under existing VRM classifications. During the siting of specific oil and gas facilities within the ARPA, opportunities would be sought to minimize the prominence of structures, minimize unavoidable open disturbance during operations, and align roads and other rights of way for reduced visibility and contrast with natural features.

The analysis assumes that in the long run, measures presented in the Reclamation Plan (Appendix B) would be implemented. Because of the large geographic area covered by the project and the fact that the specific location of project facilities is not known at this time, the reclamation measures were presented in the plan in a general, non-specific manner. The final

choice of measures to be applied at any given location would be identified by the BLM in coordination with the Operators.

In the Great Divide RMP, BLM classified 259,000 acres of the 270,000 acres in the ARPA (about 96 percent) as VRM Class III, placing it in the category that comprises about 75 percent of all land in Great Divide Resource Area. The rest of the land in the ARPA, in the vicinity of Dad, is classified as VRM Class IV.

The management objective for VRM Class III is to allow only a moderate level of contrast between project features and the existing landscape. Moderate contrast means that project features should be selected, located and designed so as to not become dominant in the landscape, though they may be evident to the viewer and may even attract the viewer's attention.

VRM Class IV allows a strong visual contrast with the landscape, meaning project features may dominate views and even be the focus of viewer attention, though even in Class IV BLM may encourage the use of topography and vegetation to screen project features and reduce visual contrast.

4.10.2 Impact Significance Criteria

In determining the level of visual contrast to be expected from the Alternatives, this analysis has followed guidance on visual contrast rating from the BLM Visual Contrast Rating Manual H-8431-1. The degree to which a management activity affects the visual quality of a landscape depends on the visual contrast created between the project and the existing landscape. Briefly, the visual contrast introduced to the landscape by features of the proposed project is rated as weak, moderate or strong based on a comparison of the development's form, line, color, and texture to the same elements in the characteristic landscape.

To arrive at an impact rating, the analysis compares the highest visual contrast that the project would cause with the management objective for VRM Class III, which, as noted, comprises 96 percent of the ARPA. The impact rating to be attributed to the Alternatives are assessed by applying criteria from Table 4-8.

As noted, the VRM objectives for the ARPA were established by the RMP through the classification of all field office lands. The classifications are the sole determinant of the allowable level of visual impact. However, the RMP also includes guidance for management decisions in a multiple use context, such as where visual and mineral resources co-exist. The RMP includes an overall objective for visual resource management in the resource area as a whole that calls for minimizing adverse effects to visual resources while maintaining the effectiveness of land-use allocations for activities based on other resources (USDI-BLM 1990). Similarly, the overall objective stated in the RMP for oil and gas resource management throughout the resource area calls for providing opportunities for development of mineral resources while protecting other resource values (USDI-BLM 1990).

The task of minimizing adverse effects on visual resources while maintaining the effectiveness of land-use allocations is undertaken by BLM as apart of site-specific analyses of specific project features. These analyses are required once a site-specific proposal and additional resource information have been submitted to the BLM for individual APD or ROW applications. The site-specific analyses would occur after approval of the project and issuance of the ROD by

BLM and before surface disturbance pursuant to an individual APD or ROW grant would be allowed to take place on federal surface or minerals.

Table 4-8. Criteria for Assigning Summary Assessment of Impacts to Visual Resources for the Development Alternatives of the Atlantic Rim Natural Gas Project.

Level of Impact	Criteria
High	Predicted visual contrast would be higher than the level of change to the characteristic landscape allowable by the visual resource management classification. For example, introduced facilities in VRM Class III that dominate the landscape by becoming the primary focus of and holding viewers' attention would be rated as a high impact.
Moderate	Predicted visual contrast would be equal to but not exceed the level of change to the characteristic landscape allowable by the visual resource management classification, For example, introduced facilities in VRM Class III that are evident in the landscape and attract attention without dominating the view of the casual observer would be rated as moderate impact.
Low	Predicted visual contrast would be lower than the level of change allowable by the visual resource management classification. For example introduced facilities in VRM Class III that are evident to viewers but otherwise conform to the landscape's natural lines, forms, colors, and textures would be rated as a low impact.

The ARPA is a large area and the Alternatives are general in describing how project features would be located within the ARPA. This analysis proceeds by considering the level of visual contrast that would result from seeing typical project features from selected roads within the ARPA. The selected roads considered by the analysis are the maintained roads that access the principal areas within the ARPA where gas development would occur and where other uses, such as recreation, occur as well.

4.10.3 Direct and Indirect Impacts

4.10.3.1 Proposed Action

During the development phase, the Proposed Action would disturb 16,000 acres to drill wells and build roads, pipelines, and ancillary facilities like compressor stations. Development would continue for approximately 20 years, and the area of maximum surface disturbance would move generally outward from the existing interim development. Therefore, although development activities would disturb a total of 16,000 acres, the amount of the un-reclaimed disturbance apparent at any one time would be less than the amount of total disturbance.

As development progresses, facilities painted Shale Green or Brush Brown (or other non-reflective color approved by the BLM VRM specialist) would be completed, sites cleaned up, and interim reclamation activities initiated. In general, interim reclamation would occur concurrently as sections of the project are completed. Interim reclamation would reduce surface disturbance to an amount of in excess of 6,000 acres that would remain disturbed throughout the production phase of the Proposed Action. The facilities and remaining surface disturbance would be in place for 30 to 50 years, the life of the project (LOP), after which facilities would be removed and final reclamation of the LOP disturbance would occur.

Features of the Proposed Action would include structures (wellheads, tanks, generator and compressor units, etc.), structure sites (reclaimed to production size), and roads with adjacent utility ROWs (reclaimed to the LOP travel surface). In addition, the acreage reclaimed as facilities are completed and put into production (interim reclamation) would be revegetated, potentially creating continued contrast with the existing landscape for several years. The period of time that this contrast would exist would be variable, since it depends on the success of the reclamation measures and on the time needed for primary succession to return disturbed areas to pre-disturbance vegetation conditions.

The Proposed Action would potentially increase the amount of oil and gas-related disturbance in the ARPA approximately ten fold (i.e., a potential maximum of 2,000 wells in place for the LOP, compared to the existing 210 wells). This would increase the likelihood of seeing a landscape in the ARPA that includes oil and gas structures, the bare soil of well pads and other facilities sites, and roads.

The appearance of gas development at 80-acre spacing would create unavoidable contrast with natural landscapes in the ARPA, especially in tracts of continuous vegetation. The highly contrasting and difficult to conceal elements of development that appear with greater frequency at the proposed density are the bare pads where well and other facilities are constructed and the network of access and service roads.

The greatest potential for seeing visual contrasts from the Proposed Action would be from the principal roads of the ARPA. These roads would likely be traveled by private property owners and recreation visitors, as well as by oil and gas-related personnel. Sensitivity to the level of visual contrast from oil and gas development would likely be highest among recreation users, who include hunters, sightseers, and wildlife observers.

Table 4-9 lists roads where users would potentially see foreground-middle ground views of oil and gas structures and related change. These are views where contrasting features would be less than three to five miles from the viewer, according to the Visual Resource Inventory Manual H-8410-1 definitions of distance zones for visual resources analysis. The roads in Table 4-9 either access the northern or the southern part of the ARPA.

Approximately 65 percent of the VRM Class III lands in the ARPA are visible from one or more of the State, County or BLM roads in or adjacent to the project area. Approximately 67% of the Class III federal lands are visible. Therefore seeing development with strong contrast to the natural landscape that dominates the view of sensitive observers is quite probable and most likely unavoidable under the Proposed Action. See Appendix M: Areas Visible from Main Roads in VRM Class III.

Users of County Roads 503 and 608, as well as BLM 3309, also would occasionally see panoramic views with the facilities, roads, and reclaimed areas of the Proposed Action in the background.

Table 4-9. Roads in the ARPA Where Users would Likely See Views of Oil and Gas Facilities Under the Proposed Action.

Northern Part of ARPA		Southern Part of ARPA	
Number	Common Name	Number	Common Name
CR 605	20 Mile Road	CR 503	Dixon Road
	Daley Road	CR 608 (west end)	Dad Road
		CR 608 (east end)	Lone Butte Road
		BLM 3305	Willows Road
		BLM 3308	Cow Butte Road
		BLM 3309	Wild Horse Road
		BLM 3320	Muddy Mountain Road

Notes:
All roads would likely access foreground to middle ground views of facilities within three to five miles or less of the viewer.
The northern part of ARPA includes the Red Rim and Jolly Roger federal lease units.
The southern part of ARPA includes the Doty Mountain, Cow Creek, Sun Dog, Blue Sky, Brown Cow, Boulder Creek, and Burbank Draw federal lease units.

When final siting decisions are made, design and location strategies would be used to screen features from view in VRM Class III areas visible from State, County or BLM roads. Utilizing existing topography to screen roads, pipeline corridors, drill rigs, well heads and production facilities is included in agency requirements for visual resources.

Some portions of the roads identified in Table 4-9 already have views of wells developed under the ARPA Operators' interim drilling program. As these views indicate, gas development does contrast with the characteristic landscape, even when designed and sited specifically for the ARPA. Judging from these examples, the greatest level of visual contrast due to the Proposed Action would occur because of bare soils on well pads, production facilities and structures, and associated roads. Specifically, geometric lines associated with these activities would contrast strongly with the characteristic vegetation and topography of the ARPA.

The reclaimed surface disturbance introduced by the Proposed Action would contrast with the ARPA landscape to a lesser degree. Reclaimed areas would contrast with undisturbed cover for several years because vegetation is slow to recover in most of the ARPA.

The adverse effects of visual contrast introduced by the Proposed Action are somewhat moderated by the VRM Class III rating of the viewshed, which allows for development so long as it does not dominate the view of the casual observer. Among users of the ARPA, hunters, sightseers and wildlife observers would likely be sensitive to the visual impacts of development. Other users of ARPA roads that would potentially have a view of gas development would likely be the livestock operators with ranching operations in the area and the personnel involved in developing and operating the Proposed Action.

Impacts to hydrologic systems and loss of vegetation would alter the character of the visual setting present in the ARPA. The proliferation of opportunistic weeds on disturbed soils would further alter the setting and inhibit the success of reclamation.

In conclusion, the adverse visual contrast introduced to the ARPA by the Proposed Action would be high. This level of contrast exceeds the maximum allowable in VRM Class III (96 percent of the ARPA) and is less than the maximum allowable in VRM Class IV (only 4 percent of the ARPA). Therefore, based on the criteria presented in Table 4-8, the impact of the Proposed Action as a whole to visual resources of the ARPA would be high, and thus significant. Impacts to visual resources from the Proposed Action would be long term, beginning during development and lasting beyond the LOP. In addition, the Proposed Action would potentially leave weak residual impacts in place on the landscape even after final reclamation at the end of the LOP because of the time it takes for reclaimed areas to return to pre-disturbance vegetation conditions.

4.10.3.2 Alternative A – No Action

Under the No Action Alternative, the Proposed Action would not be approved. The ARPA's visual character would continue to be affected by existing facilities, but no new visual impacts would be introduced, nor would management objectives for VRM Class III be exceeded by the No Action Alternative. The level of contrast introduced by the No Action Alternative would be low.

4.10.3.3 Alternative B

Developing the project area in three phases by concentrating drilling in only one zone at a time would reduce the amount of simultaneous short-term impact that would occur during the project's development phase. Development would still continue for approximately 20 years. However, instead of the area of maximum surface disturbance moving generally outward concentrically from all of the existing exploratory development "pods", only one zone would undergo concerted development at a time.

The Proposed Action anticipated that development activities would disturb an estimated 16,000 acres, but with the un-reclaimed disturbance apparent at any one time being indefinite but clearly less than the amount of total disturbance. Under Alternative B the amount of un-reclaimed disturbance apparent at any one time would still be indefinite. However, it would clearly be about one-fourth to one-third the extent of the simultaneous short-term disturbance anticipated under the Proposed Action.

Despite reducing short term impacts by phasing the development of 3 zones, Alternative B would not reduce long-term visual impacts to the ARPA remaining after the build-out of the gas fields and their operations over the life of the project. Therefore, impacts to visual resources under Alternative B would be anticipated to be high—the same as the Proposed Action.

4.10.3.4 Alternative C

Some of the development protection measures included in Alternative C would reduce the visual impacts of development. Limitations on surface disturbance in slopes over 8%, vegetation communities with high wildlife values, rare vegetation communities, proximity to water or wetlands, big game crucial winter range, grouse brood rearing and nesting habitat, silver sagebrush/bitterbrush communities, and soils with high runoff potential would help retain the visual quality of the ARPA. Road density limitations for grouse brood rearing and nesting habitat and some SMAs along with requirements for prompt interim reclamation, low impact

road designs, careful siting of well pads, roads and facilities, and dust abatement techniques would also contribute to preservation of the visual setting. See Appendix L.

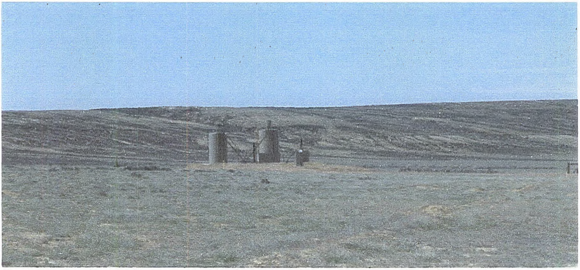
As noted in the introduction and in Section 4.10.1, Impact Significance Criteria, impacts to visual resources in the ARPA were determined by assessing the visual contrast that the project would create on the landscape of the VRM Class III rated lands which constitute 96 percent of the ARPA. In addition to the VRM classifications, a visibility analysis has been generated from points along I-80, Highway 789, County Roads and BLM roads in and adjacent to the ARPA to show what portions of the project area are visible within 5 miles of these roads.

Development protection measures for visual resources under Alternative C would further reduce the visual impact of the project. Low impact road designs would be used in visible VRM Class III areas with less than 5% slope (Appendix M: Areas Visible from Main Roads in VRM Class III with Slopes <5%) which comprise over 26% of the federal surface in the ARPA. Other measures to reduce surface disturbance, prevent facility intrusion above the skyline, do reclamation promptly, and maximize pad distance from main roads would also contribute to preservation of the visual character of the area.

Facilities and roads constructed and visible in VRM Class III under Alternative C are not expected to dominate the landscape by becoming the primary focus of and holding viewers' attention as seen from the State, County or BLM roads, and would thus be rated as having a moderate level of impact. With an anticipated reduction in short-term surface disturbance of 64% as compared to the Proposed Action, Alternative C is not expected to exceed VRM Class III Management Objectives, and impacts are not expected to be significant.

4.10.3.5 Effects Common to All Action Alternatives

Predicted change to the characteristic landscape for each Action Alternative is expected to be equal to or greater than the level acceptable under VRM Class III management objectives. The visual quality of the project area would be adversely affected until successful final reclamation and repopulation of mature native shrub communities. The project area would potentially retain numerous improved project roads which would create lasting linear features that detract from the existing character of the area.



Proper coloration helps reduce the visual impact of oil and gas facilities.

4.10.4 Monitoring and Mitigation Measures

No additional mitigation measures are necessary under the No Action Alternative.

Best Management Practices (BMPs) are warranted to reduce impacts to the level allowable on VRM Class III lands. In addition, they may reduce conflict in the long run between continued expansion of mineral development and the interests of other users of the ARPA. Shale green facility coloration would blend satisfactorily with the environment in most well locations (approximately 93% of the ARPA or 92% of the federal surface within the ARPA) as seen above. Areas that would instead require a brown coloration (approximately 7% of the ARPA or 8% of the federal surface within the ARPA) to blend with brown shrubbery and grasses are shown in Appendix M: Project Area Facility Coloration.

VRM Class III comprises 94% of the federal surface in the project area. The operator-committed mitigation measures would not be sufficient to prevent the Proposed Action or Alternative B from exceeding VRM Class III management objectives. Even BMPs would not be sufficient to keep development within Class III management objectives as prescribed in Figures 4-4 and 4-5.

Alternative C is anticipated to have a moderate impact on VRM Class III portions of the project area, assuming BMPs and additional protections afforded other programs prevent the project from dominating the viewshed and exceeding VRM Class III management objectives.

The need for more effective mitigation on all wells is an emerging issue in the GDRA. Although visual sensitivity is not the highest priority for many residents and visitors, a heightened awareness of scenic values and of the existing scenic quality is occurring for some residents and visitors as increasing numbers of sightseers and persons seeking various types of recreational opportunities pass through GDRA lands, including the ARPA.

Figure 4-4. Excerpt from Land Use Planning Handbook.

The Land Use Planning Handbook H-1601-1 (03/11/05) provides the following guidance:

I. Visual Resources

Implementation Decisions. Manage resource uses and management activities consistent with the VRM objectives established in the land use plan. Design all BLM resource uses, management activities, and other implementation decisions to meet VRM objectives established in the land use plan. Utilize visual resource management techniques and best management practices to mitigate the potential for short- and long-term impacts. Contrast ratings are required for all major projects proposed on public lands that fall within VRM Class I, II, and III areas which have high sensitivity levels (see Handbook H-8341-1 for contrast rating procedures).

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date

District

Resource Area

Activity (program)

SECTION A. PROJECT INFORMATION

1. Project Name	4. Location	5. Location Sketch
2. Key Observation Point	Township	
3. VRM Class	Range	
	Section	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM			
LINE			
COLOR			
TEXTURE			

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM			
LINE			
COLOR			
TEXTURE			

SECTION D. CONTRAST RATING ☐ SHORT TERM ☐ LONG TERM

1.

DEGREE OF CONTRAST	FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
ELEMENTS: Form												
Line												
Color												
Texture												

2. Does project design meet visual resource management objectives? ☐ Yes ☐ No (Explain on reverse side)

3. Additional mitigating measures recommended? ☐ Yes ☐ No (Explain on reverse side)

Evaluators' Names Dates

Figure 4-5 The Visual Contrast Rating Worksheet, Form 8400-4, for the project would be filled out after an alternative is selected.

4.10.5 Residual Effects

As noted, visual contrasts from wells, ancillary facilities and roads would be visible for the LOP, even with the use of BMPs, and the visual contrast from reclaimed land would have a residual effect for several years after the LOP until vegetative treatment begins to mature. The project area would potentially retain numerous improved project roads which would create lasting linear features that detract from the existing character of the area.

4.11 CULTURAL RESOURCES

4.11.1 Introduction

Cultural resources on public lands, including archaeological sites and historic properties, are protected by various laws and regulations, for example the National Historic Preservation Act of 1966 (NHPA) as amended, Governing Regulations, and 36 CFR 800. The specific directives can be found in "Archaeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines" (Federal Register 1983). Laws and regulations concerning cultural resources stipulate that the Federal Government take into consideration the effects of an action on significant cultural resources. This requires that cultural resources within the proposed area of potential effect (APE) must be identified and evaluated. A determination of effect is made and measures are then formulated to mitigate or minimize any adverse effects to those historic properties included in, or eligible for, the NRHP.

The Atlantic Rim Project Area (ARPA) data base contains at least 425 cultural resource sites in a 270,080 acre (422 sections) project area. (recorded prior to 2003 as a result of inventory of 20% of the area). Site types include prehistoric camps including burial, habitation, ceramic/pottery, stone circles, rock shelters, petroglyphs, ground stone/milling activities, and quarries. The prehistoric lithic debris sites include debris scatters/procurements, ceramics, ground stone/milling activities, and quarries.

Historic sites include trails, stage stations, inscriptions, cairns, debris/trash, ranches, irrigation ditches, ranching/herding/corrals, and a post office. Historic trails include the Overland Trail, the Cherokee Trail, and the Rawlins to Baggs Road. The Washakie Station (listed on the NRHP) and the Sulphur Springs Stage Station were stops along the Overland Trail. The Sulphur Springs Station was also utilized by the Rawlins to Baggs Road. Other stations in the ARPA associated with the Rawlins to Baggs Road include Muddy Creek Station, Soldier Wells Station, Willow Station, and the 16 Mile Station. The JO Ranch is a prominent eligible property within the project area.

Prehistoric/historic sites are characterized as prehistoric camp/historic debris scatters, or lithic scatters/historic debris scatters. Of the 425 sites recorded in the EIS analysis area to date, 32% are recommended eligible (n=136) for nomination to the NRHP, 34% are recommended not eligible (n=145), and 34% remain unevaluated (n=144). Prior to 2003, approximately 20% of the area had been inventoried at a Class III level and site density is projected to be 0.008 sites per acre. Certain topographic settings have greater archaeological sensitivity including Aeolian deposits (sand shadows and sand sheets), and to a limited degree, colluvial deposits along lower slopes of ridges. Sensitive areas include drainages such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek and Deep Creek along with their tributaries. The numerous springs in the area would likely be associated with cultural resources.

BLM has designated a quarter mile buffer surrounding the historic trails as highly sensitive and would result in the exclusion of disturbance of a maximum of 20,846 acres in order to protect the physical trace. The number of acres excluded from development would possibly be less as contributing segments are determined upon completion of inventory. For management purposes, BLM has established a two mile analysis area around the trails for consideration of the elements of setting as defined as those elements of integrity of location, feeling and association that contribute to the eligibility of the trails or associated sites. While two miles is the standard distance for consideration of setting, it does not preclude the consideration of a larger area, depending on the circumstances. The acres surrounding trails and associated Trail

for the purpose of view shed consideration has been calculated to be about 142,763 acres (not including the ¼ mile buffer). Once again, the acreage could change following field assessment

4.11.2 Impact Significance Criteria

Significance is measured by four categories defined by the Code of Federal Regulations (36 CFR 60.4):

> "the quality of significance in American history, architecture, archaeology, and culture present in districts, sites, buildings, structures and objects of state and local importance that possess integrity of location, design setting, materials, workmanship, feeling, and association; and that:
>
> A. are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B. are associated with the lives of persons significant in our past; or
>
> C. embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> D. have yielded, or may be likely to yield information important in prehistory or history."

For archaeological sites, both prehistoric and historic, significance is primarily judged either by the site's ability or potential to yield information important in prehistory or history (Criterion D) or the site's association with events that have made a significant contribution to the broad patterns of our history (Criterion A). Each site's importance, however, is determined individually, so the existence of sites eligible under criteria B or C must not be discounted. Refer to Appendix M: Alternative C – Historic Trails and 2 Mile Visibility.

The BLM meets its responsibilities under Section 106 of the NHPA through the implementation of a national Programmatic Agreement among the BLM, the Advisory Council on Historic Preservation (ACHP) and the National Conference of State Historic Preservation Officers and a State Protocol with the Wyoming SHPO rather than by following the procedure set forth in the ACHP's regulations (36 CFR Part 800).

> Destruction or alteration of all or part of a property.
>
> Isolation of a cultural resource from, or alteration of, its surrounding environment.
>
> Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting.
>
> Neglect and subsequent deterioration.

The preferred strategy of cultural resource management is avoidance of affect to those elements that contribute to the eligibility of a historic property. If this strategy cannot be implemented, mitigation of adverse effects by project redesign, data recovery, project cancellation or numerous other mitigation options may be implemented.

4.11.3 Direct and Indirect Impacts

4.11.3.1 Proposed Action

It is proposed that 1800 Coal Bed Methane Wells and 200 conventional (deep gas) wells would be drilled over the next 20 years all within the project area. According to projections, it can be estimated that 15,803 acres of new surface disturbance could be expected including well pads, roads and pipelines and ancillary facilities. At that rate of disturbance, predicting the site density to be .008 sites per acre, 126 sites could be disturbed. Of those, 32% or 40 could be expected to be eligible for the NRHP. These calculations assume that the area-wide site density is equal across the ARPA and that 20% area inventoried is a valid sample.

Direct impacts would primarily take the form of alteration or disturbance of sites. Physical disturbance of eligible sites could result from construction of well pads, access roads, pipelines and ancillary facilities (including electric lines, compressor stations, etc.). Indirect impacts to those sites would result from associated erosion resulting from the changes in surface hydrology. In turn, the loss of integrity of surface cultural material or the exposure and degradation of subsurface material and their contexts could be expected. Indirect impacts also would result from the removal of vegetation which would serve to destabilize the soils and in turn cause additional erosion of site areas. In addition, as access to previously isolated areas becomes more abundant, the frequency of human intrusion and the possibility of looting also increase.

Where the setting of the trails and associated sites contributes to NRHP eligibility, actions resulting in the introduction of visual elements that diminish the integrity of the property's significant historic features would be a factor.

4.11.3.2 Alternative A – No Action

Under the No Action Alternative, the Proposed Action would not be implemented and further drilling would be allowed on federal lands only to the extent that it would be within the scope of existing environmental analyses and individual APDs would be approved on a case-by-case basis. No additional impacts to cultural resources could be expected beyond those analyzed in the previous environmental documents for projects within the ARPA.

4.11.3.3 Alternative B

Under this alternative, development would take place at timed intervals across the project area. This alternative envisions development areas into three zones, northern, central and southern. Federal leases would not be developed within non-active areas of the ARPA until drilling and interim reclamation operations are completed for earlier pod(s). The extent of gas production facilities would continue to accumulate as time passes with ultimately the same level of operational disturbance as the other action alternatives at completion. Consequently, direct impacts to sites would be the same over time as the other Action Alternatives.

Also, no differences in effects to site settings could be expected. While visual effects to sites where setting is contributory to their eligibility would be lessened during the development phase, as producing wells accumulate across the area, visual effects would increase and ultimately match the level associated with the other alternatives. Unauthorized collection could ultimately be anticipated at the same level as the Proposed Action.

4.11.3.4 Alternative C

Generally constraints would focus on surface disturbance limitations; limited operating periods, modification of drilling and construction practices, and in some cases no surface occupancy. Under this alternative sensitive cultural resource areas would be eliminated from development or be subject to extensive mitigation measures. A by-product would be the reduction of indirect effects resulting from unauthorized collection of cultural material due to limited available access into the area.

4.11.4 Impacts Summary

Gauging the effect of any impact depends on the level of information available for that particular property provided by inventory and/or testing data. If cultural resources on or eligible to, the National Register are to be adversely impacted by the proposed undertaking, then the applicant, in consultation with the surface managing agency and the SHPO, shall develop a mitigation plan designed to eliminate the adverse effects. Construction would not proceed until the terms of the mitigation plan are satisfied. A large amount of the Overland Trail and the Rawlins to Baggs Road are located in the checkerboard land pattern. As a result, impacts from projects occurring totally on private surface would be beyond federal control.

4.11.5 Additional Mitigation Measures

Additional mitigation measures may include but not be limited to the following:

Common to all alternatives:
Mitigation of Direct Impacts

- Collocate roads and pipelines
- Brush hog rights-of-way
- Allow no surface disturbance within ¼ mile of contributing segments of historic trails or trail associated sites
- Limit trail crossings to existing disturbance corridors
- No surface occupancy of JO Ranch or surrounding 18 acres

Mitigation of Impacts to Setting where contributory to eligibility

- Paint all surface facilities a color compatible with the local environment
- Surface all roads with gravel compatible in color with the local environment
- Collocate roads and pipelines
- Relocate project or hide disturbance
- No surface occupancy of JO Ranch or surrounding 18 acres

Additional mitigation measures under the Proposed Action would include the following:
Mitigation of direct impacts

- Collocate roads and pipelines
- Brush hog rights-of-way where physically possible
- Allow no surface disturbance within ¼ mile of contributing segments of historic trails or trail associated sites
- Limit trail crossings to existing disturbance corridors

Mitigation of impacts to segments where setting contributes to eligibility

- Paint all surface facilities a color compatible with the local environment
- Surface all roads with gravel compatible in color with the local environment
- Use low profile facilities
- Collocate roads and pipelines
- Relocate or hide the disturbance
- No surface occupancy of the JO Ranch or surrounding 18 acres

Additional mitigation measures under Alternative B

Mitigation of direct impacts

- Collocate roads and pipelines
- Brush hog rights-of-way
- Allow no surface disturbance within ¼ mile of contributing segments of historic trails or trail associated sites
- No surface occupancy of the JO Ranch or surrounding 18 acres.
- Collocate roads and pipelines
- Construct smaller well pads
- Construct narrower roads
- Multiple well locations per pad in order to decrease the total number of acres of disturbance
- Limit trail crossings to existing disturbance corridors

Mitigation of impacts to segments where setting contributes to eligibility

- Paint all surface facilities a color compatible with the local environment
- Surface all roads with gravel compatible in color with the local environment
- Use low profile facilities
- Collocate roads and pipelines
- Brush hog and gravel surface for temporary roads at the drilling phase instead of constructing crowned and ditched roads on all locations.
- Begin reclamation at the earliest possible time to regenerate the native species. Actively replace native shrubs to decrease visibility.
- Limit trail crossings to existing corridors
- Construct smaller well pads
- Construct narrower roads
- Multiple well locations per pad in order to decrease visibility
- Use existing roads/two-tracks if doing so would minimize visibility otherwise construct roads in minimally visible areas.
- No surface occupancy of the JO Ranch or surrounding 18 acres.

Additional mitigation measures under Alternative C

Mitigation of direct impacts

- No surface occupancy of the JO Ranch or surrounding 18 acres.
- Allow no surface disturbance within ¼ mile of contributing segments of historic trails or trail associated sites
- Collocate roads and pipelines
- Brush hog all rights-of-way
- Construct smaller well pads
- Construct narrower roads

- Multiple well locations per pad in order to decrease the total number of acres of disturbance
- Limit trail crossings to existing disturbance corridors

Mitigation of impacts to segments where setting contributes to eligibility

- Paint all surface facilities a color compatible with the local environment
- Surface all roads with gravel compatible in color with the local environment
- Use low profile facilities
- Collocate roads and pipelines
- Brush hog and gravel surface for temporary roads at the drilling phase instead of constructing crowned and ditched roads on all locations.
- Begin reclamation at the time most optimal to regenerate the native species. Replace native shrubs to decrease visibility.
- Limit trail crossings to existing corridors
- Collocate roads and pipelines
- Construct smaller well pads
- Construct narrower roads
- Multiple well locations per pad in order to decrease visibility
- Use existing roads/two-tracks if doing so would minimize visibility otherwise construct roads in minimally visible areas.

4.11.6 Residual Impacts

Given the implementation of the additional mitigation measures outline above, no residual impact discussion is required.

4.12 SOCIOECONOMICS

4.12.1 Introduction

Implementation of any of the Action alternatives or the No Action Alternative would result in both positive and adverse socioeconomic effects. Positive effects of the Action alternatives would include increased economic activity, income, employment and increased local, state and federal government tax and royalty revenues. Adverse effects of the Action alternatives would include disruptions in activities and lifestyles of those who own private land or use public land within the ARPA, including ranchers, grazing operators, hunters, and other recreation visitors. Implementation of the No Action Alternative would avoid the disruption of activities and lifestyles associated with the Action alternatives, but would also forego the employment and fiscal benefits associated with these alternatives.

4.12.2 Impact Significance Criteria

The following criteria are used to determine whether socioeconomic impacts of the Action alternatives and the No Action Alternative would be significant:

- an increase in county or community population that would strain the ability of affected communities to provide housing and services or otherwise adapt to growth-related social and economic changes;

- an aggregate change in revenue and expenditure flows likely to result in an inability on the part of affected units of government to maintain public services and facilities at established service levels;
- permanent displacement of residents or users of affected areas that would result from project-induced changes in or conflicts with existing uses or ways of life;
- disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population, which appreciably exceed those to the general population around the Project Area.

4.12.3 Direct and Indirect Impacts

4.12.3.1 Proposed Action

Drilling and Field Development

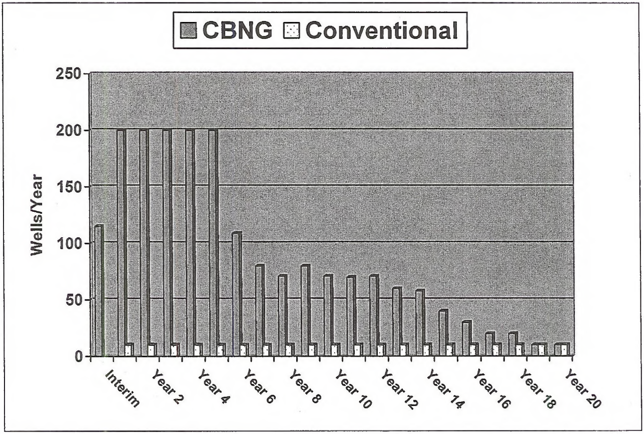
The level and pace of drilling and field development and the associated natural gas production would be key determinants of the socioeconomic effects of the Proposed Action and other Action alternatives. The pace and timing of drilling and field development within the ARPA would depend on a variety of factors including national and international energy demand and resultant commodity prices, actual production capabilities within the ARPA, and each Operator's development initiatives and strategies. This assessment assumes an annual rate of development provided by the Operators as shown in Figure 4-6. The Operators would drill a total of 2,000 wells under the Proposed Action. For the purposes of the assessment, it has been assumed that 1,800 would be CBNG wells and 200 would be conventional wells. Ten drilling rigs would be required during the first five years of the Proposed Action to achieve this pace of development. These rigs would be operating more or less continuously during the six-month drilling season.

Natural Gas Production

Figure 4-7 displays estimated Proposed Action-related CBNG production from the Atlantic Rim field. Estimates of production from conventional wells are not included in this assessment (see Section 4.12.3.1.1). APC has provided an average per/well production estimate for CBNG. Note that drilling continues throughout the 20-year drilling and field development period, therefore production is anticipated to continue for 32 years under the assumptions used for this assessment, generating ongoing economic and tax revenue effects.

Implementation of the Proposed Action would provide a substantial increment of natural gas production for Carbon County. Under the assumptions used for this assessment, gas production from Proposed Action-related drilling would not occur in the first year (production from the IDP would occur, but is not included in the assessment of impacts of the Proposed Action and Alternatives). Annual gas production from the Proposed Action would total almost 3.65 million MCF in Year 2, increase to 120 million MCF in Year 8, and then gradually decrease. For comparison, total Carbon County natural gas production in 2004 totaled 97 million MCF. Based on APC's estimated production for each successful CBNG well (750,000 MCF over 13 years) the Atlantic Rim field would produce over 1.35 TCF of CBNG over the 32-year assessment period.

Figure 4-6. Proposed Action Annual Drilling Assumptions by Well Type.



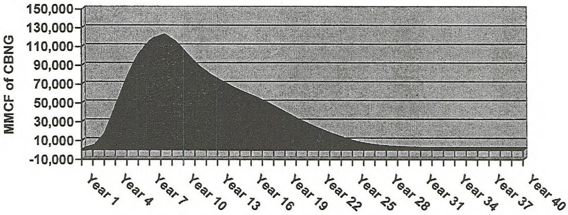
Sources: APC 2004a, BCLLC and IMPLAN model outputs

4.12.3.1.1 Economic Effects

The Proposed Action, as described in Chapter 2 of this assessment, would involve an estimated $2.1 billion capital investment for drilling, completion, gathering systems and field infrastructure, not including the investment for the IDP. This investment would occur over 20 years.

Development and operation of the Proposed Action would require goods and services from a variety of local, regional and out of state contractors and vendors in the oil and gas service industry and other economic sectors. Expenditures by the Operators for these goods and services, coupled with subsequent employee and contractor spending of earnings and profits, would generate positive economic effects in southwestern Wyoming, the State of Wyoming and the nation as a whole. These positive effects could be reduced in magnitude by Proposed Action-related reductions in other economic sectors.

Figure 4-7. Estimated Proposed Action-Related CBNG Production.



Source: APC 2004a
Note: Excludes production from the Interim Drilling Program

For this assessment, infrastructure and production estimates provided by the operators were used as inputs for a regional economic modeling process using the IMPLAN economic modeling software. IMPLAN (impact analysis for planning) is an input-output based model originally developed to assist the U.S. Forest Service in land resource management planning. Subsequently, the model and related software were transferred into the private sector, where it is the subject of ongoing refinement and enhancements to provide the analytical capacity to address a broader range of economic and impact planning issues. IMPLAN is widely recognized and accepted in regional economic and economic impact assessment circles. The model maps the flow of dollars through the region's economy and provides information about the interaction of individual sectors within the regional economy. The model considers both the direct effects on the producing sector(s) of a change in economic activity and the secondary effects on other local sectors due to the linkages within the region's economy. The model was used for the socioeconomic portion of the BLM's Southwest Wyoming Resource Evaluation (UW 1997) and for a variety of other NEPA assessments and BLM planning initiatives including the current revisions to the Rawlins Area RMP.

The model calibration and other elements of this assessment are based on the following assumptions:

- Drilling and field development in the ARPA would occur over 20 years, during which a total of 1,800 CBNG wells would be drilled, in addition to the 115 wells drilled during the IDP, with a success ratio of 100 percent, yielding a total of 1,800 producing CBNG wells (not including the IDP). For the purposes of this assessment, it is assumed that 200 conventional wells would also be drilled, also with a completion rate of 100 percent.

- The Operators estimate that each CBNG well would produce about 750,000 MCF of natural gas over 13 years. As noted above, under the Proposed Action some wells would be drilled late in the 20-year assessment period, therefore, production would continue for 13 years after the 20-year drilling and field development period ends.

- Although there are existing conventional gas wells within the ARPA, the Operators have not developed estimates for production associated with the conventional wells included in this assessment. Omitting production estimates for conventional wells may understate long-term economic, employment and fiscal benefits of production if drilling efforts in conventional formations meet with substantial success. However, because the employment and population effects of production would be substantially lower than employment and population effects of drilling and field development which are included, the assessment would not understate potentially adverse socioeconomic effects.

- Each CBNG well would require an average of $633,000 to drill and complete; an additional per well average of $379,000 would be spent on gathering and electrical systems, gas line laterals, compressor stations and injection facilities. Wells drilled to deeper conventional targets would be drilled with essentially the same equipment although completion and production techniques would differ; consequently conventional well costs are assumed to be approximately 50 percent higher than CBNG well costs.

- For the purpose of the assessment, wells would be drilled according to the schedule presented in Figure 4-6.

- Only a portion of the expenditures in each category would occur within southwest Wyoming; other materials and labor purchases would occur elsewhere in Wyoming or out of state. Estimates of local and non-local expenditures have been developed for each drilling and field development category (e.g., rig costs, labor costs, furl costs, pipe costs, etc.), based on actual APC expenditures during the interim drilling program.

- Revenues, expenditures and economic effects are expressed in terms of constant 2004 dollars.

- Annual average well head gas prices are based on the $4.25/MCF estimate for gas prices beyond 2005 contained in the October 2004 Wyoming Consensus Revenue Estimating Group Wyoming State Government Revenue Forecast (CREG 2004). These are likely conservative estimates. Note that CREG increased wellhead price estimates for natural gas to $6/MCF for 2006 and beyond in October of 2005. Spot prices at Wyoming hubs were over $10/MCF during the fall of 2005 as a result o f hurricanes Katrina and Rita.

Use of the foregoing assumptions and the IMPLAN model allow a reasonable but conservative assessment of the potential positive economic impacts of the Proposed Action and alternatives, however, economic effects of the alternatives except for No Action would be different than those forecast by the model if actual conditions vary substantially from these assumptions.

Estimated economic effects of drilling and field development are displayed in Table 4-10. Based on the foregoing assumptions, an estimated annual average direct regional expenditure of about $49 million would result in an annual economic impact of about $62 million in southwest Wyoming, or a total economic impact of almost $1.2 billion over the 20-year drilling cycle.

Estimated annual drilling and field development employee earnings in southwest Wyoming would average almost $22 million or about $434 million total over 20 years. These earnings would support an average of 578 annual job equivalents (AJE). AJE reflect an aggregation of all employees (existing and new) whose employment would be supported in whole or in part by Atlantic Rim project spending. The term AJE is used to emphasize that these are not all discrete or separate new jobs created by the Proposed Action, rather they represent both new and existing jobs and portions of jobs that are wholly or partially supported by the incremental economic activity associated with the Proposed Action.

Table 4-10. Estimated Economic Effects of Drilling and Field Development: Proposed Action.

	Direct Regional Expenditures[1]	Total Economic Impact[2]	Total Earnings[3]	Employment (AJE) Direct, Indirect & Induced)[4]
Annual Average	$49 million	$62 million	$21.7 million	578
Total	$981 million	$1.2 billion	$434 million	n/a

Source: IMPLAN Model results based on information provided by APC.
[1]Direct regional expenditures are purchases from vendors located in Carbon and Sweetwater counties by the Operators and their contractors for labor, goods and services. [2]Total economic impact reflects project-related direct expenditures and subsequent rounds of spending by vendors and employees in Carbon and Sweetwater counties. [3]Total earnings reflect wages and salaries paid to direct, indirect and induced employees associated with Proposed Action-related drilling and field development. [4]Direct, indirect and induced employment is defined in Section 4.12.3.1.3.

Estimated economic effects associated with production (not including production associated with the IDP) are presented in Table 4-11. Based on the assumptions outlined in the earlier part of this assessment, natural gas production would result in $5.7 billion in total economic impact over the 32-year production cycle (production impact estimates include impacts outside southwest Wyoming), and average annual earnings of $6.6 million supporting 161 annual average job equivalents. Production-related employment (direct, indirect and induced, defined in Section 4.12.3.1.3) would begin at an estimated 14 AJE in Year 2, increase to 461 in Year 8 and then steadily decrease. Production-related earnings and employment effects would occur in Carbon and Sweetwater counties.

Table 4-11. Estimated Economic Effects Associated with Proposed Action-Related Production.

	Total Economic Impact[1]	Total Earnings[2]	Employment (AJE) Direct, Indirect & Induced[3]
Annual Average	$200 million	$6.6 million	161
Total	$6.4 billion	$210 million	n/a

Source: IMPLAN model results based on information provided by APC.
[1] Total economic impact is the total economic activity that occurs in the region as a result of production, including the direct effect which represents the dollar value of the industry's production plus the secondary effects of increased business activity for industries that support the industry where the production occurs. [2]Total earnings reflect wages and salaries paid to direct, indirect and induced employees associated with Proposed Action-related drilling and field development. [3]Direct, indirect and induced employment is defined in Section 4.12.3.1.3

As shown in Table 4-12, the combined drilling, field development and production phases of the project would generate an estimated $7.6 billion in total economic impact, including $644 million in total earnings in southwest Wyoming over the 40-year LOP used for this assessment.

Table 4-12. Combined Proposed Action-Related Drilling and Production Economic Effects.

	Direct Expenditures[1]	Total Economic Impact[1]	Total Earnings	Average Annual Employment (AJE) Direct and Indirect)
Total	$ 6.7 billion	$7.6 billion	$644 million	578 drilling /161 production

[1] Includes impacts outside southwest Wyoming
Source: IMPLAN model results based on information provided by APC.

4.12.3.1.2 Proposed Action-Related Effects on other Economic Activities within the ARPA

As outlined in Section 3.11, existing land uses within the ARPA include wildlife habitat, grazing, hunting and other dispersed recreation, and oil and gas exploration, production and transmission.

Grazing

The economic assumptions for grazing contained in Appendix 35 of the Draft RRA RMP estimate that cattle grazing generates $64.36 per AUM in total economic impact in the region, and results in $18.77 in earnings/AUM and .000709 jobs/AUM. Each AUM of sheep grazing results in $42.36 in regional economic impact, $5.83 in earnings and generates .0009513 jobs.

Potential impacts to grazing activities and range resources are discussed in Section 4.6. In that assessment, it is estimated that grazing use of the allotments in the ARPA is 91 percent cattle and 9 percent sheep. One potential economic effect of the Proposed Action on grazing activities would be reductions in AUMs associated with losses of forage due to temporary and long-term disturbance. The total economic impact of reductions in AUMs associated with initial disturbance (2,026 AUMS) would be $126,382, assuming that the loss of forage associated with disturbance resulted in actual reductions in AUMs. Because the initial disturbance would be over the 20 year drilling and field development phase of the project, the economic impact would similarly be spread over the life of the project. It routinely takes more then one season for

reclaimed areas to become established, consequently economic impact associated with initial disturbance would be multiplied for each year required to re-establish forage, again assuming that disturbance resulted in actual reductions in AUMs.

However, the grazing assessment in Section 4.6 concludes that the amount of forage lost as a result of Proposed Action-related disturbance would be less than the normal variations in forage availability from year to year and therefore be minimal in the short-term and may actually increase available forage in the long-term because reclaimed vegetation would consist of herbaceous species, which cattle prefer. Consequently, short- or long-term disturbance-related reductions in AUMs for grazing allotments within the ARPA resulting from implementation of the Proposed Action cannot be predicted with certainty.

Some aspects of natural gas development may be beneficial for grazing operators, for example improved road access to grazing areas could facilitate livestock management for some operators, reducing costs.

Other aspects of development could generate adverse economic impacts to ranchers and grazing operators. Dust could reduce the palatability of forage near disturbed areas, requiring more intensive livestock management practices to ensure adequate forage. Incursion of noxious and invasive species could reduce available forage and require more intensive management practices. Operators may also have to manage livestock more intensively to avoid drilling and field development activity or to retrieve livestock scattered because of un-repaired damage to fences or cattle guards. More intensive livestock management practices would result in increased costs to operators. Unreported vehicle live-stock collisions could also result in economic losses for ranchers and grazing operators.

The collective effects of the above impacts could induce grazing operators whose allotments are concentrated within the ARPA to forgo use of their allotments for one or more seasons during periods of intensive development. If withdrawal of cattle were to occur, and if these grazing operators could not find comparable grazing lands within the county at comparable costs, or if they chose to forgo grazing entirely for one or more seasons, the economic impact associated with that operator's AUMs would be also be forgone. In this case, according to the range assessment in Section 4.6, losses associated with BLM allotments could range from 6,000 AUMs, which would generate a loss of $374,280 in total economic impact, to 12,000 AUMs which would generate a loss of $748,560. Including both BLM and private lands, reductions in AUMs could range as high as 20,000 which would result in a total economic impact of $1,247,600. The adverse economic impact of reductions in AUMs associated with grazing operators opting to forego use of their allotments would occur each year that cattle are withdrawn from the allotment, assuming that other grazing lands were not available.

If grazing operators were to forgo use of allotments, areas that were re-claimed would have more time to become established, reducing the potential for the spread of weeds, which could provide some economic benefit to grazing operators when they resumed use of the allotment.

<u>Recreation</u>

According to the recreation assessment contained in Section 4.9, some hunters and other recreation visitors to the ARPA may be temporarily displaced from the area by drilling and field development activity and land disturbance and by the result reductions in game. A lesser number of hunters and recreation visitors may be displaced long-term because of the loss of undisturbed landscapes and solitude. The above-referenced UW report provided estimates of

per/day total regional economic impact that range from $156 per day for non-resident hunting, $159 for non-resident OHV use and $51 per day for non-resident general recreation, and regional jobs range from 0.005/visiter day for non-resident hunting, 0.003 for non-resident OHV use to 0.001 per day for general non-resident recreation.

Estimates of the number of recreation visitors to the ARPA are not available. Estimates of the number of hunters and other recreation visitors who would be displaced temporarily or long term by the Proposed Action are similarly not available. Estimates of use of the hunt areas that include the ARPA are presented in Section 3.9 (Recreation). Based on these estimates and the total economic impact estimates of non-resident mule deer, elk and antelope hunting contained in the Draft RRMP, total economic impact of non-resident big game hunting in the hunt areas that contain the ARPA is about $1.5 million annually. Because the hunt areas are substantially larger than the ARPA, the portion of total economic impact attributable to non-resident hunting within the ARPA is smaller than the above estimate.

Big game hunting is economically important to communities near the ARPA. A number of landowners within the ARPA provide outfitting services to non-resident hunters and some lease their land to outfitters or allow hunting for a fee. This activity provides additional income for landowners; in years when cattle or sheep prices are low, it provides a substantial portion of total income (Caricco 2004, Hicks 2004, Hansen 2004, O'Toole 2004). Also motels, RV parks, cafes, convenience stores and gas stations in the Little Snake River Valley derive a portion of their business from big game hunters (Hicks 2004). Consequently, substantial reductions in big game hunting within the ARPA would have adverse economic effects on land owners, outfitters and businesses in the Little Snake River Valley. For individual land owners and outfitters, these losses could range from minimal to substantial, depending on the location of natural gas development in relation to a specific property, the timing of development, actual effects on big game and big game habitat, climatic conditions, the duration of adverse effects and the success of mitigation measures. Economic effects to businesses in the Little Snake River Valley could be offset by the economic activity associated with the Proposed Action.

4.12.3.1.3 Employment and Population Effects

Employment

Population effects of the Proposed Action would be associated with direct, indirect and induced employment. Direct employment would include workers in oil and gas service occupations, construction or other sectors involved in some aspect of Proposed Action-related drilling, field development or production. Indirect employment would include jobs and portions of jobs created by industries purchasing from other industries in response to local spending associated with the Proposed Action. Induced employment would be created by direct, indirect and induced employee spending of Proposed Action-related income for goods and services, and would occur across most economic sectors.

As a result of the Proposed Action, direct, indirect and induced jobs would be created in Carbon and Sweetwater counties, and include:

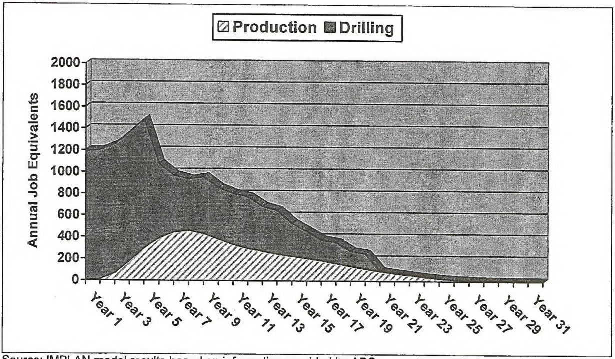
- temporary jobs, primarily in drilling, natural gas service and related construction industries, which would be primarily filled by non-local workers who would relocate to the area for the duration of the particular work assignment, and to a lesser extent by existing southwestern Wyoming residents. Work assignments can range in length from six months to a matter of hours at any one location.

- existing direct, indirect and induced jobs and portions of existing jobs that have in the past been linked to or supported by natural gas drilling, field development or production activities and would continue to be supported by these activities under the Proposed Action; and

- new jobs and portions of new jobs filled by existing southwest Wyoming residents or by in-migrant workers who relocate to southwest Wyoming for employment. In-migrant workers are defined as workers who move into the area for project-related employment purposes.

Figure 4-8 displays estimated total employment associated with the drilling/field development and production phases of the Proposed Action.

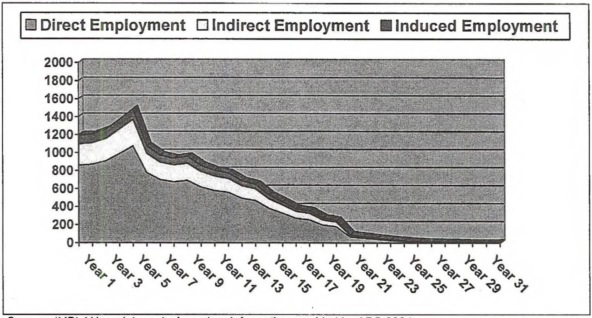
Figure 4-8. Estimated Proposed Action Total Drilling and Production Employment: Direct, Indirect and Induced.



Source: IMPLAN model results based on information provided by APC

Figure 4-9 displays the direct, indirect and induced components of Proposed Action-related employment.

Figure 4-9. Components of Total Proposed Action-Related Employment: Direct, Indirect and Induced.



Source: IMPLAN model results based on information provided by APC 2004

Population

Although the employment and income effects of the Proposed Action would be substantial and sustained at a high level of activity for 8 to 10 years, the Proposed Action is likely to result in moderate long-term population growth. A number of factors in the natural gas industry and the local economy would likely intervene to reduce the population effects of the economic stimulus.

Chief among these is the existence of a mature oil and gas service industry infrastructure in southwest Wyoming. Drilling and field development activities in the ARPA would be performed by a combination of local contractors (primarily located in Rawlins and Rock Springs, and to a lesser extent, the Little Snake River Valley and Wamsutter) and regional and national oil and gas service firms, many with local presences in these same communities. Between 1995 and 2004, APDs in Carbon and Sweetwater counties increased over 300 percent. In response to this activity, oil and gas service firms have expanded, particularly in Rock Springs, which is the major oil and gas service center for southwest Wyoming.

During the nine-year period that drilling activity increased dramatically in the two counties, Carbon County resident population decreased by five percent and Sweetwater County resident population decreased by seven percent. There are several apparent reasons for this phenomenon.

- Many oil and gas drilling and service companies are staffed by employees with primary residences in other parts of the country. These employees relocate to Carbon and Sweetwater counties in single status (i.e., without family members), on a temporary basis, and return to their homes when they are off shift, or at the end of their work assignment (Blodgett 2004, Kilgore 2004, Kot 2004). In some cases, these employees

are considered double transients who temporarily relocate to a service company's office in Rock Springs, and travel to other communities and stay in motels or RV parks for a matter of days, returning to Rock Springs for another assignment (Blevins 2004). Because of their temporary nature, these employees are not full time residents and therefore often not counted in population estimates, even though they generate demand for temporary housing and for some local government services.

- Coal mining employment decreased in both counties during the period and trona mining/soda ash manufacturing employment decreased in Sweetwater County, as did logging and lumber manufacturing in Carbon County. Some mine and timber industry employees may have obtained work in the oil and gas service industry and some indirect and induced employees may have retained jobs they otherwise would have lost because of economic activity in the oil and gas sector. As a result, increasing oil and gas industry activity may have slowed population decline in the two-county area.

- At the beginning of the accelerated drilling cycle, oil and gas service firms may have had some underutilized capacity and the local labor pool may have supplied a portion of the increased labor demand.

- During the mid 1990s several major construction projects helped maintain population in Sweetwater County as these projects were completed, workers left contributing to population decline.

Given that the allowable drilling period in the ARPA fields runs from June through October only, and drilling and field development in many other southwestern Wyoming gas fields are similarly limited to certain parts of the year, it is likely that many drilling and gas field service workers would continue to relocate to Carbon and Sweetwater counties on a temporary, single status basis, returning to their homes or relocating to other projects during the off season. This observation is supported by the fact that school enrollment in Carbon and Sweetwater counties declined by 26 percent and 29 percent, respectively, during the nine year period when drilling increased by over 400 percent, indicating that gas service industry workers have not relocated with families. Declines in school enrollment are also a result of declines in other employment and of aging populations in the two-county area. Indications are that school enrollment is beginning to increase in Rawlins and the Little Snake River Valley (Herold 2005, Kilgore 2005).

As noted above, the natural gas service industry in Carbon and Sweetwater counties has expanded considerably over the last several years in response to the increased drilling and field development activity in southwest Wyoming, and would likely be able to accommodate some portion of the activity associated with the Proposed Action with existing infrastructure and labor force. Additionally, there were four drilling rigs operating in the ARPA during 2004 under the IDP, and the local portion of field construction and gas service industry employment to serve this level of development (about 40 percent of the peak-year of the Proposed Action) is presumed to be already in place.

For this assessment, each employment category (direct, indirect and induced) has been assigned a residency status (non-local temporary, local and inmigrant) depending on the characteristics of the work, the existing labor pool and historical labor factors in southwestern Wyoming. The "local" category is further divided into existing employees (i.e., those who are already working and their employment would be sustained in whole or in part by the economic activity associated with the Proposed Action) and a smaller category of workers who would

obtain new employment as a result of the Proposed Action. Table 4-13 displays the hiring status factors used for this assessment.

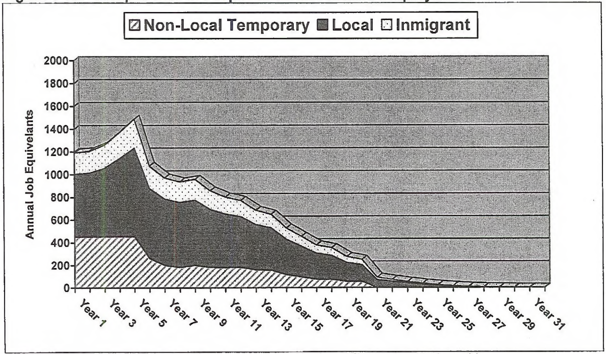
Figure 4-10 displays the estimated non-local temporary, local and inmigrant components of Proposed Action-related employment. During the fifth year of drilling, when an estimated peak of 1,488 direct, indirect and induced AJE would be associated with Proposed Action-related activities, an estimated 453 or 30 percent would be non-local and temporary, 780 or 52 percent would be local (already employed in jobs that would be sustained by Proposed Action-related activities or living locally and obtain new employment in a job created in response to Proposed Action-related activities) and 256 or 17 percent would be in-migrants (workers who relocate to the area with households on a longer term basis). The percentage of locally hired workers reflects the local portion of the 40 percent of the drilling and field development workforce that has been working on the IDP.

Table 4-13. Hiring Status of Proposed Action-Related Employment.

Employment Category	Non-Local Temporary	Local		Inmigrant
		Existing Employees	New Hires	
Drilling/Field Development				
Direct	50%	30%	5%	15%
Indirect	25%	45%	5%	25%
Induced	0%	75%	10%	15%
Operations				
Direct	0%	20%	30%	50%
Indirect	0%	75%	10%	15%
Induced	0%	50%	35%	15%

Source: BCLLC

Figure 4-10. Components of Proposed Action-related Employment.



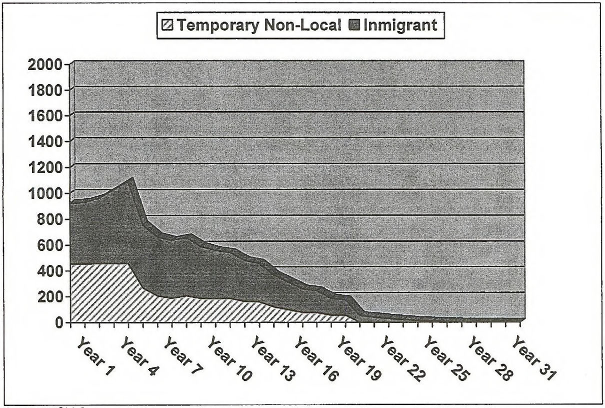
Source: BCLLC Note: Local category includes both existing workers and new hires.

The distinction between non-local temporary, local and in-migrant workers is useful because each would have different population implications and different demands for community services.

For this assessment, temporary non-local workers are assumed to relocate to southwestern Wyoming in single status, for six months or less. Local workers are assumed to be currently living and working in southwestern Wyoming. In-migrant workers are assumed to relocate to southwestern Wyoming bringing an average household size of 2.5 persons, the average household size for the State of Wyoming at the time of the 2000 census.

Based on these assumptions, the Proposed Action would result in a peak of 456 additional non-local single status temporary workers during the Year 1 through Year 5 of the Proposed Action and a peak in-migrant population of 1,096 during Year 5 of the Proposed Action (see Figure 4-11).

Figure 4-11. Proposed Action–Related Peak Temporary Single-Status and Inmigrant Population.



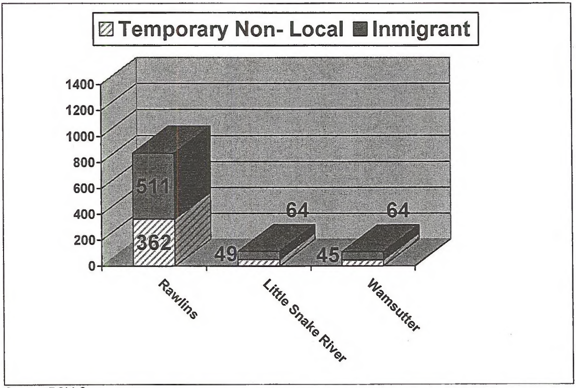
Source: BCLLC

Based generally on the size of the community, proximity to the ARPA and available housing, the Proposed Action-related population has been distributed to Rawlins (80 percent), Baggs and Dixon in the Little Snake River Valley (just over 10 percent) and Wamsutter (just under 10 percent). Using these percentages, Rawlins would receive a Proposed Action-related population of 873 persons (362 temporary and 511 longer term) during the peak (Year 5), Baggs and Dixon

in the Little Snake River Valley would receive a total of 113 (49 temporary and 64 longer term) and Wamsutter would receive a total of 109 (45 temporary and 64 longer term) (Figure 4-12).

It is important to note that these numbers are in addition to the population associated with existing direct, indirect and induced workers currently living in these communities whose employment would be supported in whole or in part by Proposed Action-related economic activity.

Figure 4-12. Distribution of Peak Year Proposed Action-related Population to Communities.



Source: BCLLC

Based on the above population estimates and the percentage of total population enrolled in school during 2000 (about 18 percent in Carbon County and in the State of Wyoming as a whole) an estimated 92 school age children associated with the Proposed Action would be enrolled in schools in Rawlins during the peak year (fifth year of drilling and field development), 11 would be enrolled in schools in the Little Snake River Valley and 12 would be enrolled in Wamsutter.

The Wyoming Division of Economic Analysis projects that Rawlins, Baggs, Dixon and Wamsutter would have small decreases in population over the next several years (WDEA 2004); if these projections are correct, the population associated with the Proposed Action may reduce population loss in these communities. However, it is more likely in the near term that the anticipated high-levels of natural gas development in southwest Wyoming may result in higher total population gain and for Wamsutter in particular, the Town may experience considerable temporary short-term population gain during the construction of two interstate pipelines and the

development of a worker housing facility by BP America near the town see Chapter 5 for a discussion of potential cumulative effects).

4.12.3.1.4 Housing Effects

First year and peak-year (fifth year of drilling and field development) housing demand associated with the Proposed Action is displayed in Table 4-14. Non-local temporary workers are anticipated to share housing at a rate of 2 workers per unit. For longer term housing demand, it is anticipated that every household would include an average of 1.2 workers and have an average size of 2.5 persons, the average size of Wyoming households identified by the 2000 U.S. Census.

As with population, it is important to note that the housing demand does not include housing currently occupied by existing workers whose employment would be supported in whole or in part by Proposed Action-related activities.

Table 4-14. First Year and Peak-Year (Year 5) Proposed Action-Related Housing Demand, by Type.

	Proposed Action-Related Housing Demand by Community					
	Rawlins		Little Snake River Valley		Wamsutter	
	1st Year	Peak Year	1st Year	Peak Year	1st Year	Peak Year
Temporary	181	181	23	24	23	23
Longer Term	125	170	16	21	16	21
Total	306	351	39	45	39	44

Source: BCLLC

Based on the housing inventory contained in Section 3.12, the Proposed Action-related increment of demand for both short-term and longer-term housing coupled with demand from other gas development projects would likely strain or exceed currently available resources in all communities within the analysis area.

Based on capacity, the motels, recreational vehicle parks and mobile home parks would be adequate to accommodate demand from temporary workers associated with the Proposed Action, however, competition from cumulative natural gas development demand would likely result in the need for drilling and field development contractors to provide temporary housing in the form of dormitory units or construction camps, depending on the level of activity occurring at the time (see Chapter 5 for a discussion of cumulative housing demand). It is becoming increasingly common for drilling and gas field service companies to provide mobile dormitory units for temporary workers and such units add to a community's temporary housing resources without creating an oversupply of units when drilling and field development is completed.

A portion of the longer term population associated with the Proposed Action could be accommodated in mobile home parks in Rawlins although demand from other projects may cause competition for these resources. Rawlins has some currently unused pads in mobile home parks and may initially attract both temporary and longer-term workers because of these resources, and because much of the initial development would likely occur in the central and

northern parts of the ARPA. As the development moves to the southern portion of the ARPA and as communities in the Little Snake River Valley and Wamsutter respond to the demand, more long-term workers may relocate to these communities.

Longer–term housing availability is currently tight in both Wamsutter and the Little Snake River Valley although there is some subdivision activity in Wamsutter and limited dispersed housing development in the Little Snake River Valley. The longer tenure of the relatively small increment of housing demand would allow time for local housing markets to respond to demand for rental or owner-occupied housing units. But it may be that some Proposed Action-related operations workers would initially have to seek housing resources in mobile home parks in Rawlins and either wait for housing to become available in the Little Snake River Valley or Wamsutter or contract for development of new housing.

4.12.3.1.5 Effects on Community Services

As discussed in Section 3.12, most community facilities in Carbon County and the communities near the ARPA were developed for a substantially larger population than currently exists. As a result, the population increment associated with the Proposed Action could be readily accommodated by most existing community facilities and by area schools. The enrollment increment in Rawlins could strain the elementary school capacity if Proposed Action-related enrollment were to be concentrated in the lower grades; however, given the excess capacity in the middle school and high school, capacity should be adequate if enrollment is evenly distributed. Additionally, Rawlins should have a new elementary school and completed remodeling of the middle school by the time the peak year occurs.

The additional water supply that the recently completed High Savery reservoir would provide to the Town of Baggs would accommodate the relatively small population increment projected for that community. A new Carbon County jail has recently been completed, which should alleviate overcrowding, at least for the near term. Some project-related tax revenues associated with the Interim Drilling Program would be available to offset increased service demand, but, because ad valorem property taxes from production would provide the largest source of project-related revenue to county and special district government and affected schools, there would be a several-year lag before substantial Proposed Action-related revenues flow. Given recent increases in natural gas production from other fields and elevated natural gas prices, Carbon County and affected special districts may have substantial revenues to deal with the increase in service demand associated with the Proposed Action until production-related revenues begin to flow.

Local government services most affected during the annual six-month drilling and field development season are likely to be law enforcement, emergency response (fire suppression and ambulance) and county roads (effects on county roads are discussed in Section 4.13). As demonstrated in Section 4.12.3.1.6, Carbon County would receive substantial revenues to help support increased demand for these services over the life of the project.

Although Proposed Action-related local government facility and service demand in Rawlins is anticipated to be moderate and demand in smaller municipalities is anticipated to be minimal, it is worth noting that communities would receive few direct revenues from Proposed Action-related development or production, therefore impacts which result in demand for new infrastructure or services are unlikely to be directly offset by Proposed Action-related revenues. Wamsutter is located in Sweetwater County and would therefore receive no project-related tax

revenues except a small portion of severance tax revenues distributed to local governments throughout the state.

4.12.3.1.6 Fiscal Effects

The Proposed Action would generate substantial tax revenues including:

- local ad valorem property taxes on production and certain field facilities;
- sales and uses taxes on materials, supplies and equipment;
- Federal and State Mineral Royalty payments; and,
- Wyoming State severance taxes.

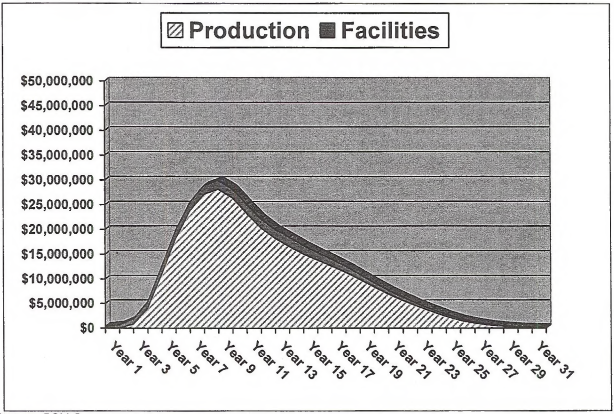
4.12.3.1.6.1 Ad Valorem Property Taxes

The Proposed Action would generate ad valorem property tax to Carbon County, the Wyoming School Foundation Fund, Carbon County School District #-1 and a number of special taxing districts. Direct ad valorem property taxes would be generated from two sources: (1) the value of natural gas produced and sold; and (2) the value of certain well field and production facilities (underground facilities associated with wells are exempt). Indirect ad valorem tax revenues may be generated by the infrastructure investments made by gas service companies and vendors that expand facilities as a result of the incremental economic activity. Long term employees of gas companies and vendors may purchase new properties or improve existing properties generating additional property taxes. Potential indirect revenues have not been estimated for this assessment.

Constant 2003 mill levies were used to prepare property tax estimates. The Wyoming School Foundation Program and shared county school mill levies are set by statute. Other mill levies are set each year by the county commissioners and officials of the various taxing districts within limits imposed by the state legislature; some change each year. Mill levies reflect the revenue needs of the taxing entity and estimates of assessed valuation within the entity. Natural gas is assessed based on the previous year's production. Well field facilities are depreciated after the first year of production.

Figure 4-13 displays annual Proposed Action-related ad valorem property tax estimates, based on the assumptions outlined earlier and assuming a constant total mill levy of 62.85 mills. Table 4-15 displays estimated ad valorem property tax revenues to major property taxing entities in Carbon County. Under the assumptions used for this assessment, ad valorem property tax revenues from production and facilities would total $349 million over the 32-year life of the project, or an annual average of almost $11 million.

Figure 4-13. Proposed Action-Related Ad Valorem Property Tax Estimates.



Source: BCLLC

Carbon County and certain special districts would receive approximately $96 million over 32 years under the assumptions used for this assessment. Note that some affected special districts only cover part of the ARPA; therefore an average of special district levies has been used for the assessment.

Table 4-15. Estimated Proposed Action-Related Ad Valorem Property Tax Revenues: Carbon County and Affected Special Districts.

	County (12 mill)	Weed & Pest (1 mill)	Recreation (1mill)	Conservation Districts (1 mill)	Avg. Total Special Districts (2.35 mill)	Total County & Special Districts
Total (32 year)	$66.6 million	$5.6 million	$5.6 million	$5.6 million	$13 million	$96 million
Average Annual	$2.1 million	$173,000	$173,000	$173,000	$408,000	$3 million

Note: Table does not breakout all special districts. Columns may not sum due to rounding.
Source: BCLLC

Table 4-16 displays Proposed Action-related revenues that would accrue to local schools and to the Wyoming School Foundation fund that benefits schools across the state. A portion of the revenue collected under the School District U-1 26.5 mill levy would accrue to the Wyoming School Foundation Fund, because the district is a "recapture" district under the provisions of the School Foundation Program, which means that revenues above a certain level are collected by the state for redistribution to other school districts (see Chapter 3). District U-1's budget could increase as a result of student enrollment increases associated with Proposed Action-related longer term population.

Table 4-16. Estimated Proposed Action-Related Ad Valorem Property Tax Revenues: Carbon County School District # 1 and Other School Entities.

	School Dist U1 (26.5 mill)*	State School Foundation Fund (12 mill)	County School (6 mill)	BOCES (1 mill)	Total Schools
Total (32 year)	$147 million	$66.6 million	$33.3 million	$5.6 million	$252.6 million
Average Annual	$4.6 million	$2.1 million	$1 million	$173,000	$7.9 million

* Much of the revenue associated with District U1 levy is likely to accrue to the Wyoming School Foundation Fund.
Note: Columns may not sum due to rounding.
Source: BCLLC

It should be noted that mill levies that produce revenues in excess of expenditures are frequently reduced; the potential for reduced mill levies in Carbon County is high given anticipated increases in both production and gas prices. Reduced mill levies would benefit county property owners and other commercial and industrial interests in the county and likely result in positive economic effects.

4.12.3.1.6.2 Federal and State Mineral Royalties and Wyoming Severance Taxes

The federal government collects a 12.5 percent royalty on the fair market value of gas produced from federal leases, less production and transportation costs. Half of the mineral royalty revenues are returned to the state where the minerals were produced. In Wyoming, a portion of the state's share is distributed to local governments and to the Wyoming School Foundation Fund. It is difficult to predict with certainty where all CBNG wells within the ARPA would be located. For this assessment, it is assumed that 64 percent of the CBNG associated with the Proposed Action would be produced from federally-owned minerals, 31 percent would be produced from privately-owned minerals and 5 percent would be produced from minerals owned by the State of Wyoming. As noted above, production associated with conventional wells has not been estimated for this assessment.

The State of Wyoming collects either a 16 2/3 percent or a 12 ½ percent royalty on natural gas produced from state-owned minerals, depending on the circumstances of the lease. For this assessment, State mineral royalties were assumed to be 12 ½ percent.

The State of Wyoming collects a six percent severance tax on the fair market value of natural gas produced within the state. Federal mineral royalty payments and production and

transportation costs are exempt from this tax. The state distributes revenues from this fund to a variety of accounts including the General Fund, Water Development Fund, Mineral Trust Fund, and Budget Reserve, and distributes a fixed one percent of the revenues to counties and municipalities.

Estimated mineral royalty and severance tax revenues are displayed in Table 4-17. Actual mineral royalty and severance tax revenues would vary based on production levels, well locations, gas sales prices, and actual production and transportation costs. Actual severance tax revenues may be less than these estimates if a portion of the gas is used for production purposes.

Table 4-17. Federal Mineral Royalty and Wyoming Severance Tax Estimates.

	40 Year Total	Average Annual
Federal Mineral Royalties	$320 million	$10 million
Wyoming Share of Federal Mineral Royalties	$160 million	$5 million
Wyoming State Mineral Royalties	$8.4 million	$264,000
Wyoming Severance Taxes	$271 million	$6.8 million

Source: BCLLC
Note: Columns may not sum due to rounding.

4.12.3.1.6.3 Sales and Use Tax

Wyoming collects a four percent sales and use tax on the gross receipts of sales of tangible goods and certain services (drilling services are exempt). The state returns 31 percent of the revenue (less administrative costs) to the county where the taxes were collected. Counties distribute the revenues to incorporated municipalities based on population. As a local option, Carbon County also collects a one-percent general-purpose sales and use tax which is distributed to the county and its municipalities and a one-percent dedicated sales and use tax for capital facilities.

Table 4-18 displays the estimated state and local revenues which would flow from expenditures made during the drilling and field development phase of the Proposed Action, assuming that all sales and use tax payments are appropriately credited to Carbon County. Total sales and use tax revenues over the 20-year drilling cycle would be $17.2 million dollars. Of the total, an estimated $ 9.5 million would be distributed to the State of Wyoming and $7.7 million to Carbon County and its municipalities. In addition, the Proposed Action would contribute one percent of taxable sales until the current local option facilities tax expires, these revenues have not been estimated.

Table 4-18. Estimated Sales and Use Tax Revenues and Distributions.

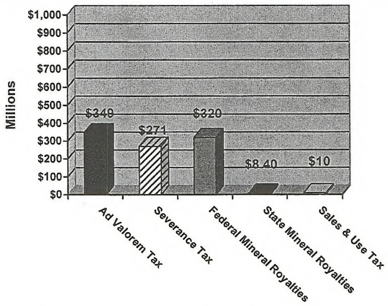
	State of Wyoming					
Total	$5.4 million					
Average Annual	$271,000					
	Carbon County Total	County Share	Rawlins	Baggs	Dixon	All Other Towns
Total	$4.4 million[1]	$623,000	$2.5 million	$98,000	$22,000	$1.1 million
Average Annual	$220,000	$31,000	$127,000	$4,900	$1,100	$56,000

[1] Excludes proceeds from 1 percent local option facilities tax.
Note: Columns may not sum due to rounding.
Source: BCLLC

4.12.3.1.6.4 Total Revenues

Figure 4-14 summarizes the estimates of the main tax and royalty revenues attributable to the Proposed Action. The revenues are based on production, gas sales prices, tax rates and exemption estimates, all of which are subject to change as development proceeds. In addition to these revenues, other revenues would be associated with the Proposed Action including sales and use tax payments for ongoing operations of the project and from employee and vendor spending, Oil and Gas Conservation charges, and federal income tax payments by the proponent and its employees. These revenues have not been estimated for this assessment.

Figure 4-14. Total Ad Valorem Property Tax, Federal Mineral Royalty, Severance Tax and Sales and Use Tax Revenues Associated with the Proposed Action.



Source: BCLLC

4.12.3.1.7 Local Attitudes, Opinions and Lifestyles

The Proposed Action has the potential to affect local attitudes, opinions and lifestyles in two ways. Affected communities would experience change related to the increase in economic activity, employment and population growth associated with natural gas development. The Proposed Action also has the potential to affect ranchers who own land in the ARPA, and users of the project area such as grazing operators, outfitters, hunters and other recreationists.

Carbon County has a relatively long history of oil and gas development; consequently residents are familiar with natural gas industry activities and their economic benefits. The combination of familiarity and anticipated economic benefit creates a climate of general community acceptance of and support for continued natural gas development in Carbon County, particularly in Rawlins, and the Little Snake River Valley. Because the economy of Carbon County has generally declined since the early 1980s due to closure of several coal mines and problems in the timber industry, many residents of Carbon County and Rawlins welcome the current economic expansion resulting from natural gas development (Kilgore 2004, Grabow 2004). Rawlins in particular has unused public and commercial infrastructure that could be redeveloped to accommodate population growth.

Within this general climate of acceptance are resident attitudes and values that may diminish support or create opposition for a particular development proposal. These attitudes and values include concern for use of public lands and preservation of wildlife habitat and recreation resources.

These attitudes and values are evident in a number of the comments submitted during the scoping process for this EIS. Additionally, a discussion of these attitudes and values, as expressed by Carbon County residents, is included in the findings of the 1996 resident survey conducted for the Carbon County Land Use Plan (discussed in Section 3.12).

According to the Carbon County Land Use Plan, resident response to the survey suggests "a need to balance the conservation of natural resources and the economic viability of resource-based industries in the county." This sentiment coupled with partial support for leasing more federal lands for oil and gas development (about 50 percent countywide) suggests that development of natural gas resources on existing leases could be generally supported by residents of Carbon County, as long as they perceive that such development does not damage wildlife habitat or degrade the quality of recreation resources in the area.

Some land owners and grazing operators within the ARPA, the group that would be most directly affected by the Proposed Action, have mixed feelings about the development. While they generally support resource development on public lands and believe development of natural gas resources within the ARPA is in the national interest, they are concerned about the potential effect on their operations, about changes in the currently relatively undeveloped landscape and about effects to their traditional way of life (Hansen 2004, Hicks 2004, O'Toole 2004).

Members of this group have expressed some or all of the following concerns:

- fragmentation of the landscape, grazing lands and wildlife habitat caused by gas field roads, well pads and infrastructure;
- disruption of grazing operations;

- soil erosion from disturbance and the potential effects of erosion on streams and stock ponds;
- the potential for encroachment of weeds on disturbed land, particularly since the recent drought has weakened and killed some native plants;
- the increased potential for trespass and damage to private lands and improvements given the increased access that well field roads would provide;
- affects on game (many ranchers also have outfitting operations on their lands or lease lands to outfitters and hunters); and
- the potential that the Operators may seek more dense well spacing in the future, further increasing the potential for each of the above identified impacts.

Other sections of this assessment analyze potential impacts to range resources, noxious and invasive species and wildlife and wildlife habitat and a variety of measures to mitigate these impacts are either committed or proposed. Some ranchers and grazing operators are concerned that mitigation measures for these identified impacts would not be rigorously enforced or effective.

But even if mitigation measures are enforced and effective, most ranchers and grazing operators believe that the Proposed Action would change the current relatively undisturbed character of much of the rangeland/wildlife habitat within the ARPA. The effect would be to introduce or expand resource extraction, a type of low density industrial use, which would in turn alter their traditional use and way of life.

Based on these observations, it is likely that the Proposed Action would receive general support in Carbon County communities, but specific groups with interests and concerns more directly affected by the Proposed Action, such as landowners, grazing operators, outfitters and recreation users of the ARPA would experience varying degrees of dissatisfaction with the change in use of the land.

4.12.3.1.8 Environmental Justice

Executive Order (EO) 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (defined as those living below the poverty level).

Environmental Justice includes impacts to air, water or other environmental values or health and safety risks that are experienced disproportionately by minority or low income populations. As noted in Section 3.12, there are no human populations (including populations in these categories) located within the ARPA. There are no residences within the ARPA that are occupied year round, although some residences on ranches are temporarily or seasonally occupied. The ARPA is relatively distant from population centers, so no populations would be subjected to direct physical impacts from the Proposed Action. Therefore the Proposed Action would not directly affect the health and safety of any minority or low income populations, nor would it directly affect their social, cultural, or economic well-being.

The Proposed Action could result in beneficial effects on low-income populations living in communities near the ARPA area, however. The Proposed Action would create or sustain an annual average of 578 jobs (annual job equivalents) over the 13 year drilling and field

development phase of the project, and an annual average of 161 jobs during the production phase of the project. These direct, indirect and induced employment opportunities would occur in all sectors of the economy and provide additional job opportunities for unskilled low-income residents as well as those that might become skilled through local training programs. The increased labor demand would have the likely effect of reducing unemployment in the county and increasing labor force participation, two factors that could also increase incomes in low-income populations.

While in many cases skilled workers would be imported into the area to fill skilled and specialized labor demand, the availability of local unemployed or under- employed individuals would offer the companies the opportunity to retain workers who are already located and housed within the area. The applicant- committed measure to "Implement hiring policies that would encourage the use of local or regional workers who would not have to relocate to the area" should enhance this opportunity.

Employment of local unemployed or under–employed individuals for skilled or specialty occupations would require training and development, generally in a trade school or institution of higher education. Post high school training in Carbon County is currently offered by the Carbon County Higher Educational Center. Management, administrative, technical and trade-related training and certification opportunities are offered, including some energy industry-specific courses and certifications. Some courses qualify for college credit and can lead to college degrees and/or trade certification. The opportunity for post-high school level education for both blue collar and white collar jobs within Carbon County could provide opportunities for low-income residents to obtain and benefit from skilled and specialty employment locally.

4.12.3.2 Alternative A - No Action

Drilling and Field Development

Under this alternative the ARPA area would not experience the CBNG development associated with the Operator's proposal. Those portions of the Atlantic Rim with existing wells and interim drilling activity could continue to operate and produce gas with associated effects as disclosed in previous NEPA documents.

Production

Under this alternative no incremental natural gas production would occur within the ARPA area, beyond that associated with existing wells and the IDP.

4.12.3.2.1 Economic Effects

Implementation of this alternative would not generate incremental economic benefits to leaseholders, area residents, governmental agencies, or surface or sub-surface mineral owners.

4.12.3.2.2 Alternative A-Related Effects on other Economic Activities within the ARPA

Ranchers, grazing operators and local businesses that serve recreation visitors and hunters within the ARPA would not experience incremental effects beyond those associated with the IDP and existing oil and gas development under alternative A.

4.12.3.2.3 Employment and Population Effects

Employment

Implementation of Alternative A would not be anticipated to result in substantial changes in employment within the analysis area.

Population

Implementation of Alternative A would not be anticipated to result in substantial changes in local population levels within the analysis area.

4.12.3.2.4 Housing Effects

Implementation of Alternative A would not be anticipated to result in substantial changes in demand for temporary or longer-term housing demand within the analysis area.

4.12.3.2.5 Effects on Community Services

Implementation of Alternative A would not be anticipated to result in substantial changes in demand for community services within the analysis area.

4.12.3.2.6 Fiscal Effects

Implementation of Alternative A would not be anticipated to result in substantial changes in local government fiscal conditions within the analysis area.

4.12.3.2.7 Local Attitudes, Opinions and Lifestyles

Under Alternative A, the change in relatively undisturbed landscapes would be limited to those associated with the IDP. No incremental dissatisfaction associated with CBNG activities and disturbance would be anticipated for ranchers and grazing operators within the ARPA and for individuals that use the ARPA for outfitting, hunting or other recreation purposes.

Other local residents who may have benefited economically from the proposed AR development may be dissatisfied with the forgone opportunities.

4.12.3.2.8 Environmental Justice

No low income or minority populations would be directly affected by Alternative A. The indirect increases in employment opportunities for minority and low income residents associated with the AR project would not occur under this alternative.

4.12.3.3 Alternative B

4.12.3.3.1 Economic Effects

Because the pace and level of drilling and level of production are assumed to be the same as under the Proposed Action, Alternative B-related economic effects, would be similar to those associated with the Proposed Action.

4.12.3.3.1.1 Impacts to Leaseholders

Economic and fiscal effects to leaseholders could occur under Alternative B. Federal oil and gas leases (Form 3100-11) give the leaseholders the exclusive right to drill for, mine, extract, remove, and dispose of all the oil and gas within the lease area. Rights granted are subject to applicable laws, the terms, conditions, and attached stipulations of the lease. Under this alternative, federal leases within the Atlantic Rim EIS area would not be developed within inactive zones. Development activities would not be approved until the subject zone becomes active. BLM would direct suspensions of operations and production for all currently inactive leases within inactive zones. Here "inactive leases" mean where a lease does not contain active producing or service wells or where production is allocated to a lease. Proposals to develop leases within inactive zones would be denied until the zone becomes active for development under the Atlantic Rim ROD.

Proposals for development within the active area would be received, analyzed, and approved as appropriate. Existing oil and gas operations outside of the active development zone would continue as it currently exists. The existing ARPA pods outside of the active zone could be developed to the extent allowed in the existing individual EA Decision Record for the project. For those leases suspended by the BLM no lease rental fees would accrue and the lease term would be tolled until activity is allowed on the lease. The lease would remain in this status during the period the zone remained in an inactive status.

No revenue from the suspended oil and gas production would be realized during the term of the suspension by leaseholders and the BLM. Delayed revenue from the inactive area could possibly be off-set by increased revenue from the actively developed areas for royalties and taxes for governmental authorities, and possibly by leaseholders who have leases in both zones. Correlative rights issues could occur along boundaries of active areas due to drainage of natural gas resources. Drainage of oil and gas resources within inactive zones would be viewed as lost revenue to the lessees and the BLM. Depending on the ownership of the minerals this drainage would affect federal, fee and state mineral estates.

BLM doesn't approve or control development proposals upon state and private lands. Within inactive zones not open to development under the ARPA ROD proposals for rights-of-way authorization across federal lands for oil and gas development and production related activities could be received, be processed, and as appropriate approved or disapproved by the BLM. This authority arises from the BLM Manual, Part 2800.06 "Policy", which states

> *"It is the policy of the BLM to:*
> *D. Allow owners of non-federal lands surrounded by public lands managed under FLPMA a degree of access across public lands which would provide for the reasonable use and enjoyment of the non-federal land."*

4.12.3.3.2 Alternative B-Related Effects on other Economic Activities within the ARPA

Under Alternative B economic effects to ranchers, grazing operators , outfitters, hunters and other recreation visitors would be similar to those associated with the Proposed Action except that potential economic effects would be concentrated in a specific zone during the period that the zone would be active for drilling and field development purposes. Concentrating drilling and field development activities in an active zone may increase negative effects on other economic activities (grazing, outfitting, hunting and other recreation) within the active zone. As drilling and field development is completed in an active zone. Effects on other economic activities would

diminish within that zone. Effects on other economic activities in inactive zones would be minimal while the zone was inactive.

The concentration of drilling and field development activities in the smaller geographic area of a zone would increase the likelihood that grazing operators whose allotments are principally located within an active zone may chose to forgo use of the allotment for one or more seasons during periods of intensive development in that zone. As with the Proposed Action, if these grazing operators cannot find comparable grazing lands within the county at comparable costs, or if they chose to forgo grazing entirely for one or more seasons, the economic impact associated with that operator's AUMs would be also be forgone for the period of non-use.

4.12.3.3.3 Employment and Population Effects

Employment

Employment effects of Alternative B would be similar to those associated with the Proposed Action, except that drilling and field development employment would be concentrated in each zone as it becomes active.

Population

Depending on the location of the particular active zone, the residential distribution of drilling and field development workers under Alternative B may deviate slightly from the estimates for the Proposed Action, as workers may attempt to find housing in communities nearer their work site.

4.12.3.3.4 Housing Effects

Similarly under Alternative B, demand for temporary housing to accommodate field development workers may shift to communities nearer a particular zone as that zone becomes active.

4.12.3.3.5 Effects on Community Services

Minor differences in demand for community services may occur under Alternative B as contrasted to the Proposed Action. These would be associated with the minor differences in population distribution as drilling and field development workers seek temporary housing near active zones.

4.12.3.3.6 Fiscal Effects

Local, state and federal government fiscal effects for alternative B are expected to be similar to those identified for the Proposed Action, except that ad valorem tax revenues for certain special districts may differ in timing when development in an active zone is outside the district's boundaries. Over time, given the assumptions used for Alternative B, total revenues would be similar to those identified under the Proposed Action.

4.12.3.3.7 Local Attitudes, Opinions and Lifestyles

Alternative B-related effects on local attitudes opinions and lifestyles would be similar to those associated with the Proposed Action, except that effects of development of previously undisturbed landscapes would be delayed for inactive zones until development occurred. The more intensive levels of activity in a zone associated with the condensed development period

for that zone could result in elevated levels of dissatisfaction for ranchers, grazing operators, outfitters, hunters and other recreation visitors who use that zone.

4.12.3.3.8 Environmental Justice

No minority or low-income populations would be directly affected by project activities associated with Alternative B; therefore Alternative B would not be anticipated to have disproportionate adverse effects upon minority or low income populations.

As with the Proposed Action, indirect beneficial effects of Alternative B would be expected to include increased employment opportunities for Carbon County residents including low income and minority populations. The current availability of higher-education and training opportunities within Carbon County may allow low income and minority residents the opportunity to obtain better paying skilled and specialty jobs.

4.12.3.4 Alternative C

Because the pace and level of drilling and level of production under Alternative C is assumed to be the same as under the Proposed Action, impacts to local socioeconomic conditions would be expected to be similar to those associated with the Proposed Action. However, development protection measures that resulted in lower levels of drilling or production would also result in lower values for all socioeconomic elements.

4.12.3.4.1 Economic Effects

Economic effects of Alternative C would be anticipated to be similar to those associated with the Proposed Action. Reductions in economic effects could occur if fewer wells were allowed or economically feasible under development protection measures. Similarly, changes in production levels or operating costs associated with development protection measures would result in different economic effects than those associated with the Proposed Action.

4.12.3.4.1.1 Impacts to Leaseholders

Under this alternative natural gas development could be proposed anywhere within the ARPA area during the life of the Atlantic Rim project. In some areas surface disturbance restrictions from the various development protection measures would limit the amount of surface disturbance allowable. Construction and development constraints could arise where resources such as wildlife, vegetation, soils, visual, recreation, erosion or other environmentally sensitive conditions exist and / or overlap. Where development protection measures are applied, natural gas extraction could be constrained, potentially leaving un-extracted natural gas resources in the ground and causing corresponding increased relative construction and operations costs and decreased revenues. Limited operating periods would affect the timing of development and could affect the intensity and cost of construction activities by focusing them into tighter construction windows.

4.12.3.4.2 Alternative C - Related Effects on other Economic Activities within the ARPA

Under Alternative C, economic effects to ranchers, grazing operators, outfitters, hunters and other recreation visitors would be similar to those associated with the Proposed Action except that development protection measures that reduce impacts to range resources, wildlife, wildlife

habitat and scenic values could result in fewer adverse economic effects to grazing operators, ranchers, outfitters and businesses that serve recreation visitors to the ARPA as compared to the Proposed Action.

Given the substantially smaller area of disturbance associated with Alternative C, it is less likely that grazing operators whose allotments are concentrated within the ARPA may chose to forgo use of the allotment or it is likely that they would forgo use of a portion of the allotment rather than the whole allotment. Still, if these grazing operators could not find comparable grazing lands within the county at comparable costs, or if they chose to forgo grazing entirely for one or more seasons, the economic impact associated with that operator's reduction in AUMs would be also be forgone for the period of non-use.

4.12.3.4.3 Employment and Population Effects

Employment

Employment effects of Alternative C would be similar to those associated with the Proposed Action, except that drilling and field development activity could intensify in response to development requirements associated with development protection measures that forced drilling activities into a tighter window or diminish if fewer wells are ultimately allowed or economically feasible under these restrictions.

Population

Population effects of Alternative C would be anticipated to be similar to those identified under the Proposed Action. Differences could occur related to the employment effects identified above.

4.12.3.4.4 Housing Effects

Housing effects of Alternative C would be anticipated to be similar to those identified under the Proposed Action. Differences could occur related to the employment and population effects identified above.

4.12.3.4.5 Effects on Community Services

Demand for community services related to Alternative C would be anticipated to be similar to those identified under the Proposed Action. Differences could occur related to the employment and population effects identified above

4.12.3.4.6 Fiscal Effects

Fiscal effects of Alternative C would be anticipated to be similar to those identified under the Proposed Action. Reductions in production-related property and severance taxes and Federal Mineral Royalties could occur if fewer wells were allowed or economically feasible under development protection measures. Certain facility-related property and sales tax revenues could increase if development protection measures required special production or gathering facilities. Increased operations cost could also reduce federal mineral royalty, state severance tax and county ad valorem property tax revenues on production.

4.12.3.4.7 Local Attitudes, Opinions and Lifestyles

Effects on local attitudes opinions and lifestyles associated with Alternative C would be similar to those associated with the Proposed Action, except to the extent that development protection measures preserved key environmental values within the area, ranchers, grazing operators, outfitters, hunters and other recreation users could be likely to experience less dissatisfaction with the changes to the relatively undisturbed landscapes in certain portions of the ARPA.

4.12.3.4.8 Environmental Justice

No minority or low-income populations would be directly affected by project activities associated with Alternative C; therefore Alternative C would not be anticipated to have disproportionate adverse effects upon minority or low income populations.

As with the Proposed Action, indirect beneficial effects of Alternative C would be expected to include increased employment opportunities for Carbon County residents including low income and minority populations. The current availability of higher-education and training opportunities within Carbon County may allow low income and minority residents the opportunity to obtain better paying skilled and specialty jobs.

4.12.4 Impacts Summary

Economic impacts of natural gas development and production would be largely positive under the Proposed Action and Alternatives B and C. Based on the assumptions used for this assessment, natural gas development would enhance regional economic conditions and generate substantial local, state and federal tax and royalty revenues. Economic benefits would be similar for the Proposed Action and Alternatives B and C, unless development and the associated production were precluded from a specific area. Economic and fiscal benefits to leaseholders could also be less under Alternatives B and C.

Natural gas-related economic benefits may be diminished slightly by reductions in grazing, hunting and other recreation activity in the project area under all Action Alternatives and individual land owners and outfitters within the ARPA could experience economic losses associated with reductions in hunting activity. For individual land owners and outfitters, these losses could range from minimal to substantial, depending on the location, development in relation to a specific property, the timing of development, actual effects on big game and big game habitat, the duration of adverse effects and the success of mitigation measures. Businesses in the Little Snake River Valley that provide goods and services to hunters could also experience reductions in income from reductions in hunting activity. For many of these businesses, reductions in hunting activity would be offset by increases in drilling and field development activity.

For all action alternatives, the population increment associated with drilling and field development coupled with cumulative drilling and field development activities would be likely to strain existing housing resources. The relatively small in-migrant population increment anticipated for communities in the Little Snake River Valley and Wamsutter could be accommodated by existing community infrastructure. Project-related sales tax, use tax and property tax revenues would offset project-related demand for local government services in Carbon County, although revenues may lag demand in the early years of the project. Rawlins and the communities in the Little Snake River Valley would receive minimal direct tax revenues

from natural gas development and Wamsutter would receive no direct revenues, except for a relatively small portion of mineral royalties and severance taxes.

Community acceptance of natural gas development would be mixed. Many residents would support the development, but land owners, grazing operators, outfitters, hunters and other recreational users of the ARPA are likely to experience varying degrees of dissatisfaction with the change in land use and the change in character of lands within the ARPA. The level of dissatisfaction would be correlated with the level, pace and location of development, therefore the Proposed Action is likely to result in higher levels of dissatisfaction for more people in affected groups than the other two action alternatives.

4.12.5 Mitigation

The economic and employment effects of all three Action Alternatives would be substantially positive. The Operator–committed policy of hiring local workers, to the extent that such workers are available, would enhance local economic and employment effects and reduce demand for housing and community services.

The Operator-committed policy of coordinating project activities with ranching operations to minimize conflicts involving livestock movement or other ranch operations, including scheduling of project activities to minimize potential disturbance of large-scale livestock movements and establishing effective and frequent communication with affected ranchers to monitor and correct problems and coordinate scheduling, could reduce conflicts and dissatisfaction among some directly affected users of land within the ARPA.

Because project-related demand for both temporary and longer-term housing is likely to strain or exceed existing housing resources in all communities in the assessment area when coupled with cumulative demand, it may be necessary to develop rig camps and construction camps for project workers. The development of these camps would also free up spaces in mobile home parks in Rawlins, which could be used by longer-term workers until the local housing market is able to respond to longer-term demand.

During the interim drilling program, the BLM RFO has initiated a transportation planning process with representatives of directly affected interests in the BLM including the BLM, WGFD, Carbon County, the LSRCD (representing landowners and grazing operators), and the Operators. Although initially intended to address transportation issues, it has emerged as a forum for identifying existing and potential development issues and opportunities and developing cooperative approaches to addressing issues and opportunities. As this process evolves and matures, it has the potential for reducing conflict and dissatisfaction with CBNG development in the ARPA.

4.12.6 Residual Impacts

Even after implementation of the mitigation measures, it is likely that dissatisfaction would remain among some landowners, grazing operators, outfitters, hunters and other recreational users of public lands within the ARPA.

4.13 TRANSPORTATION

4.13.1 Introduction

This section identifies potential effects of the Proposed Action, No Action, and other Action Alternatives on the transportation system providing access to the ARPA (federal and state highways and Carbon County roads) and the road network within the ARPA (Carbon County roads, BLM roads, private roads and Operator-maintained roads). Potential effects of new and improved roads within the ARPA on soils, noxious and invasive species, range resources, wildlife habitat, recreation resources and visual resources are described in sections 4.3, 4.5, 4.6, 4.7, 4.9 and 4.10 respectively.

The RMP (USDI-BLM 1990) contains the following Transportation Management Direction common to all alternatives:

> "The public land transportation system would be maintained or modified to provide for public health and safety and adequate access to public lands."

4.13.2 Impact Significance Criteria

The following criterion is used to determine whether transportation impacts would be significant:

- Increases in traffic levels on the local public transportation system that would cause the level of service on the system to fall below acceptable levels as defined by the responsible government agency.

4.13.3 Direct and Indirect Impacts

4.13.3.1 Proposed Action

<u>Highways and Roads Providing Access to the ARPA</u>

Transportation effects of natural gas development and production would include increased traffic on federal and state highways and county roads providing access to the ARPA, primarily US I-80, WY 789, WY 70, CCR 605N and CCR 608. Depending on the outcome of the Coordinated Transportation Planning process described below, traffic could also increase on CCR 501, CCR 503 and BLM Road 3309.

Although access from WY 71 on the east side of the ARPA is possible from several Carbon County roads, there are no communities in that area, consequently few trips would originate from areas served by those routes.

Most traffic accessing Pods 1 through 4 (Red Rim, Jolly Roger Alpha and Beta and the currently dormant Pod #1) would travel on Carbon County 605N. Trips originating in Rawlins would access CCR 605N southwest of Rawlins. Trips originating in Rock Springs or Wamsutter would travel I-80 east to CC 605N; trips originating in the Little Snake River Valley are likely to travel WY 789 north and I-80 east to the CCR 605N entry point.

Traffic accessing Pods 5 through 9 (Doty Mountain, Sun Dog/Cow Creek, Blue Sky, Brown Cow and Muddy Mountain) are likely to use CCR 608, entering the ARPA east of Dad. Trips

originating in both Rawlins and Rock Springs would travel I-80 west to WY 789 south to Dad, trips originating in Wamsutter would use SCR 23/CCR 701 (the Wamsutter/Dad Road) east and trips originating in the Little Snake River Valley would use WY 70 west to WY 789 north, entering CCR 608 at Dad. Although some trips originating in the LSRV and destined for the Muddy Mountain Pod may enter the ARPA from the south, using CCR 503 or CCR 501, the Operators intend to establish primary access from CCR 608 and develop a new road or improve existing roads from the north to provide access to the Muddy Mountain pod. CCR 503, which passes through Cottonwood Canyon north of Dixon, is a narrow winding road which passes through areas with important resources values. CCR 501 is minimally improved in its upper reaches and would require substantial improvement to serve as a primary access point from the south. These factors and the fact that most ARPA traffic will originate in communities to the north would discourage heavy use of these roads for project access.

Access to the southwestern portion of the ARPA is possible using BLM Rd #3309; however, this road is only minimally improved and crosses critical wildlife habitat. Both the BLM and the Operators intend to develop policies to discourage use of this road for project access.

Table K-2 (Appendix K) shows the estimated average number of trips associated with drilling, field development and well field operations activities. Drill rigs and certain other items of heavy equipment would be transported to the ARPA and remain within the project area until their relevant work is completed. Materials and supplies would be delivered on an as-needed basis. Drilling and completion crews would commute to ARPA daily. Other contractors and vendors would commute on an intermittent, as-needed basis.

Average annual daily traffic (AADT) estimates were developed based on a simulation of drilling activities for typical CBNG and conventional wells, construction of ancillary facilities, performance of routine operations activities and well workovers and consideration of miscellaneous visits. Based on the results of the simulation, the Proposed Action would generate an estimated AADT of 419 (210 round trips) during the peak drilling year (Year 5). This would include an AADT of 254 for drilling and field development activities. Note that AADT is calculated on a 365-day basis and drilling and field development activities would be limited to six months out of each year, so average daily traffic would be substantially higher during the active drilling period or about 490 trips or 245 round trips per day. During the peak drilling year, AADT for well field operations would be an estimated 165 (83 round trips) for 840 producing wells. In subsequent years, drilling and field development traffic would diminish but operations traffic would increase as more wells come into production until 2025 when wells would begin to come off-line under the assumptions used for this assessment (see Figure 4-15). Under the assumptions used for this assessment, Proposed Action-related AADT would be in the 350 to 430 range for about 20 years.

Table 4-19 contrasts peak drilling year (Year 5) AADT for federal and state highways providing access to the ARPA with 2002 and projected 2012 AADT on those highways. Proposed Action-related peak drilling-year AADT would total 2 percent of 2002 AADT on I-80, 28 percent of 2002 AADT (51 percent of truck AADT) on WYO 789 and 9 percent of 2002 AADT (63 percent of truck AADT) on WY 70. Peak drilling year Proposed Action-related traffic would make up a slightly lower percentage of projected 2012 traffic except on WY 789, where base traffic is anticipated to decrease by 2012. However, given the potential for increased drilling and field development in the area, these traffic forecasts may change.

The Proposed Action-related increase in traffic, particularly truck traffic, would accelerate maintenance requirements on federal and state highways. Wyoming severance tax revenues

and the State's share of federal mineral royalty revenues associated with the Proposed Action would offset these costs. The Proposed Action-related increase of traffic on federal and state highways would result in a corresponding increase the statistical probability of accidents on these highways, although actual accident rates would depend on a variety of factors.

Figure 4-15. Proposed Action AADT Estimates, Drilling/Field Development and Operations: 2005 – 2044.

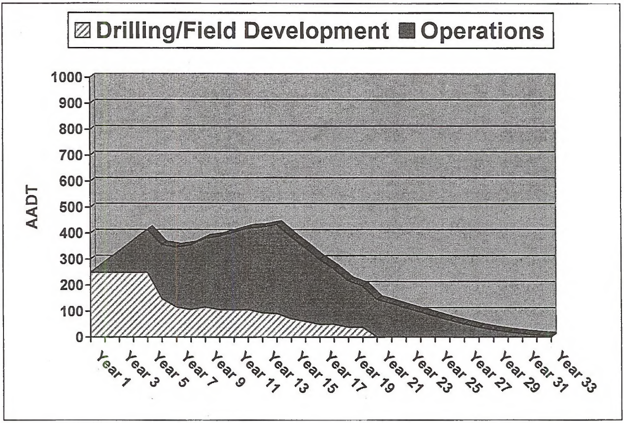


Table 4-19. Proposed Action Peak Drilling Year (Year 5) AADT Compared with 2002 AADT and 2012 Projected AADT on Affected Highways.

Highway	2002 AADT	Projected 2012 AADT	Estimated Peak Drilling Year AADT	% 2002 AADT	% Projected 2012 AADT
I-80 (Junction WY 789)	11,760 (6,460 trucks)	15,000	213 (96 trucks)	2% (1% trucks)	1%
WY 789 (Creston Jct. - Baggs)	860 (210 trucks)	800	240 (108 trucks)	28% (51% trucks)	30%
WY 70 (Dixon west)	480 (30 trucks)	550	42 (19 trucks)	9% (63% trucks)	8%

Table 4-20 displays estimated peak drilling year AADT on Carbon County roads providing access to the ARPA. Although no current traffic counts are available for these roads, the estimated peak year traffic would be a substantial increase over pre-gas development volumes.

As described in Section 3.12, CCR 605N has been extensively improved by the Carbon County Road and Bridge Department to accommodate natural gas traffic. The estimated volume of traffic on CCR 605N would require a relatively high level of ongoing maintenance by the county.

Table 4-20. Proposed Action Peak Year (2008) AADT on Affected Carbon County Roads.

Carbon County Road	Peak Year AADT
CCR 605N (20 Mile Road)	184
CCR 608 (Wild Cow Road)	230
CCR 501 (Cherry Grove Road)	4

The Carbon County Road and Bridge department plans to conduct extensive improvements to CCR 608 during 2005, also to accommodate the high level of anticipated natural gas traffic. Although some ARPA road improvement projects have been conducted under a cooperative effort between Carbon County and the Operators, the county has been required to fund improvements and increased maintenance activities in advance of substantial tax revenue flows from ARPA natural gas development. However, as described in Section 4.12.3.1.6, Carbon County would receive substantial project-related ad valorem property taxes as production begins to flow.

<u>Access within the ARPA</u>

Currently, CCR 605N, CCR 608 and BLM Road 3305 serve as the transportation "spine" within the ARPA. Operator-constructed roads provide access from these roads to the pods. Based on the Operators' estimate of an average of 0.5 miles of new roads per well, an initial total of 1,000 miles of new roads would be developed over the 20-year drilling and field development period. The Operators would be required to construct new roads and improve existing roads to BLM standards, except in cases where roads cross private surface. Operators would also be required to maintain new and existing roads that access natural gas facilities within the ARPA.

Potential positive effects of the Proposed Action on the transportation network within the ARPA would include improved access and new access to portions of the ARPA for landowners, grazing operators and recreation users. Potential negative effects would include damage to important resource values. Portions of the ARPA are located in areas that contain sensitive resources. Construction of new roads or improvement of existing roads in these areas have the potential to impact those sensitive resources, although successful implementation of BLM road standards, RMP stipulations, Operator-proposed mitigation measures, the preconstruction planning and site layout process and the coordinated transportation planning process described in Section 4.13.5 would reduce these impacts.

The traffic associated with Proposed Action-related drilling, field development and operations would require substantial improvements on Carbon County and BLM roads used for access within the ARPA and would also accelerate maintenance requirements on existing, upgraded and new roads. Exacerbating road maintenance factors include the unavoidable use of roads during wet and muddy conditions to maintain gas field facilities and excessive speed.

Carbon County would have substantial costs associated with improving and maintaining county roads for natural gas development and operations. The substantial revenues that would accrue to the county from natural gas production would offset these costs; however, Carbon County has and would expend funds for road improvement and maintenance in the ARPA prior to receipt of substantial project-related revenues.

The increased traffic in the ARPA, particularly during the drilling and field development phase, would correspondingly increase the potential for vehicle/livestock accidents and conflicts with livestock operations and damage to range improvements (gates, cattle guards, etc.) during that period. These potential impacts are discussed in Section 4.6.

4.13.3.2 Alternative A - No Action

Under Alternative A- No Action, transportation effects would be limited to impacts associated with previously approved oil and gas development. No additional roads would be created, and traffic would be limited to trips necessary to develop and maintain production of existing wells and wells associated with the IDP.

4.13.3.3 Alternative B

Transportation effects of Alternative B would be similar to those associated with the Proposed Action, .however, focusing development into active zones would temporarily increase the amount of traffic on area roads providing access to and within an active zone, possibly requiring higher standard collector roads, and higher levels of maintenance. Transportation impacts in inactive zones would be delayed until those zones become active.

Impacts to highways and roads providing access to the ARPA could also change as development is concentrated in a particular zone. For example more traffic could be anticipated to access the ARPA from Dad during development of the central zone, causing corresponding reductions in traffic on the northern or southern access highways and roads. Concentrations of traffic on access routes would change as development proceeded from zone to zone.

4.13.3.4 Alternative C

Transportation effects of Alternative C would be similar to those associated with the Proposed Action, except that development protection measures could reduce the number of roads in portions of the ARPA with high environmental values and/or result in re-routing of roads to avoid such areas. Where development protection measures require re-routing of roads, limitations on disturbance, or other actions, additional road development costs and increased road construction times could occur. Under the ARPA EIS Record of Decision, specific effects from implementation of these measures would be identified during subsequent site-specific NEPA analyses conducted in response to specific development proposals.

4.13.4 Impact Summary

Transportation effects of natural gas development and production associated with the Proposed Action and other Action Alternatives would include increased traffic on federal and state highways and county roads providing access to the ARPA. There would also be a statistical increase in the potential for accidents on these roads.

Transportation effects within the ARPA would occur on Carbon County, BLM, private and Operator-maintained roads. Operators would be required to construct new roads and improve existing roads to BLM standards, except in cases where roads cross private surface. Operators would also be required to maintain new and existing roads accessing natural gas facilities within the ARPA. All action alternatives would increase and improve access within the ARPA for ranchers, grazing operators and recreation users. Conversely development of new roads and improvement of existing roads could adversely affect resource values and result in higher road maintenance costs for Carbon County, which would be offset by project-related revenues to the county.

4.13.5 Mitigation Summary

In addition to the Operator-committed measures, a coordinated transportation plan (TP) would be developed for the ARPA. A TP would minimize construction of new roads, foster proper sizing of roads and assign road maintenance responsibilities. The coordinated transportation process would include the BLM, the Operators, Carbon County, WYDOT, the LSRCD, WG&F, private landowners, livestock operators and other affected parties. The initial transportation planning effort would identify the most efficient and resource-sensitive locations for collector and local roads (existing roads would be used as collectors and local roads whenever possible to minimize the amount of surface disturbance within the area). In addition to development of new roads, the ARTP would consider administrative closure and seasonal closure of existing roads, and the restriction of well field traffic on certain existing roads. The transportation planning process would also consider erosion prevention and minimization and prevention and eradication of noxious and invasive species.

Transportation planning would continue to occur on an annual basis to 1) assess ongoing effects on resource values, 2) identify the minimum road network necessary to support annual drilling and field development activities, 3) review and assign construction and maintenance responsibilities, 4) identify roads appropriate for abandonment and reclamation, and 5), identify fences, gates and cattle guards which should be upgraded to accommodate heavy trucks and equipment.

Operator responsibilities for preventive and corrective maintenance of roads in the ARPA would extend throughout the duration of the project and include blading, cleaning ditches and drainage facilities, dust abatement, control of noxious and invasive species, maintenance of fences, gates and cattle guards and other requirements as directed by the BLM and private landowners.

4.13.6 Residual Impacts

The transportation impacts described above would continue throughout the LOP. The implementation of the transportation planning process would help minimize residual impacts on transportation systems. Under the action alternatives a residual network of improved roads could be left in place of the existing two-track and lower standard roads depending on the needs of the BLM, Carbon County, and surface owners.

4.14 HEALTH AND SAFETY

4.14.1 Introduction

Potential health and safety impacts associated with the action alternatives are similar to those associated with existing conditions in the ARPA, although the risk of certain types of impacts would increase as the amount of natural gas development increases. Potential health and safety impacts include occupational hazards associated with oil and gas exploration and development, risk associated with vehicular travel on improved and unimproved roads and range fires.

4.14.2 Impact Significance Criteria

No specific health and safety standards were identified in the GDRA RMP. IN general health and safety effects of the action alternatives would be considered significant if they resulted in substantially increase risk to the public.

4.14.3 Direct and Indirect Impacts

4.14.3.1 Proposed Action

Potential health and safety effects associated with the Proposed Action include hazards associated with natural gas development and operations; risk associated with vehicular travel on county, BLM and Operator-maintained roads; firearms accidents during hunting season and by casual firearms use such as plinking and target shooting; and natural events such as range fires.

Health and safety impacts of the Proposed Action would include a relatively low risk to project workers from industrial accidents, firearm accidents and natural disasters. There would be a slight increase in risk of traffic accidents and range fires for the general public during drilling and field development; that increased risk would be reduced but not eliminated during field operations.

<u>Occupational Hazards</u>

The US BLM, OSHA, USDOT and WOGCC each regulate certain safety aspects of oil and gas development. The primary federal regulations related to health and safety requirements for oil and gas operations are specified under 43 CFR Ch. II, subpart 3162.5. These regulations require the prior approval of a drilling and operations plan by the BLM that addresses the procedures to be employed for protection of environmental quality, including safety precautions, control and removal of waste, spill prevention, fire prevention and fire fighting procedures. Adherence to relevant safety regulations on the part of the Operators and enforcement by the respective agencies would reduce the probability of accidents. Additionally, given the remote nature of the project area, and the relatively low use of these lands by others (primarily grazing operators and hunters), occupational hazards associated with the Proposed Action would mainly be limited to employees and contractors rather than the public at large.

<u>Pipeline Hazards</u>

Increasing the miles of gathering and transmission pipelines within the ARPA would increase the chance of a pipeline failure. However, the low probability of failure, the remoteness of the

project area and the low level of anticipated non project-related construction and excavation would result in minimal risk to public health and safety. Compliance with signing requirements for pipeline rights-of-way would reduce the likelihood of pipeline ruptures caused by excavation equipment - particularly in the vicinity of road crossings or areas likely to be disturbed by road maintenance activities.

Hazardous Materials

Drilling, field development and production activities require use of a variety of chemicals and other materials, some of which would be classified as hazardous. A Hazardous Materials Management Plan is provided as Appendix C to this document, pursuant to BLM Instruction Memoranda Numbers WO-93-344 and WY-94-059, which require that all NEPA documents list and describe any hazardous and/or extremely hazardous materials that would be produced, used, stored, transported or disposed of as a result of a proposed project.

Potential impacts associated with hazardous materials include human contact, inhalation or ingestion and the effects of exposure, spills or accidental fires on soils, surface and ground water resources and wildlife.

The risk of human contact would be limited predominately to ARPA Operator and contractor employees. A Hazard Communication Program, Spill Prevention Control and Countermeasure (SPCC) Plans, and other mitigation measures described in Appendix H, Required Best Management Practices would reduce the risk of human contact, spills and accidental fires, and provide protocols and employee training to deal with these events should they occur.

Other Risks and Hazards

Highway and road safety impacts are discussed in Section 4.13 (Transportation). Sanitation and hazardous material impacts would be avoided or reduced by the implementation of the mitigation measures outlined in Appendix H, Required Best Management Practices.

The potential for firearms-related accidents would occur primarily during hunting season. The increased activity in the ARPA during drilling and field development would be likely to discourage hunting in the immediate vicinity of the activity during that period. Consequently the risk of fire arms-related accidents should be minimal. During project operations, the relatively few personnel on site would also result in minimal risk of firearms-related accidents.

The risk of fire in the project area would increase under the Proposed Action. This risk would be associated with construction activities, industrial development and the presence of fuels, storage tanks, natural gas pipelines and gas production equipment. However, this risk would be reduced by the placement of facilities on pads and locations that are graded and devoid of vegetation, which could lead to wildfires. In the event of a fire, property damage most likely would be limited to construction or production-related equipment and range resources. Fire suppression equipment, a no smoking policy, shutdown devices and other safety measures typically incorporated into gas drilling and production activities would help to minimize the risk of fire. There would be a heightened risk of wildfire where construction activities place welding and other equipment in close proximity to native vegetation. Given the limited public use and presence in the project area, the risk to the public would be minimal. There would be a small increase in risk to area fire suppression personal associated with the Proposed Action.

There would be an increased potential for weather related hazards associated with the Proposed Action. Many development locations in the ARPA are remote and rapidly moving storms can impair or prevent driving conditions in a fairly short time. It is possible that workers may get stranded in remote locations requiring rescue operations by emergency management personnel. Proper training of development and operations workers, coordination with emergency management agencies and frequent mapping of development locations can reduce the potential for weather related impacts.

Based on the foregoing assessment, risks to public health and safety should not substantially increase as a result of the Proposed Action.

4.14.3.2 Alternative A - No Action

Under this alternative no oil and gas related development would occur so no effects to health and safety would occur for this alternative.

4.14.3.3 Alternative B

Under this alternative effects are anticipated to be the same as the Proposed Action.

4.14.3.4 Alternative C

Under this alternative effects are anticipated to be the same as the Proposed Action.

4.14.4 Mitigation

The mitigation measures would be sufficient to mitigate risks to public health and safely.

The Operators should coordinate emergency response planning with the Carbon County Emergency Management Agency and provide documentation regarding compliance with Federal Hazardous Material Regulations and the Uniform Fire Code.

4.14.5 Residual Impacts

Risk to health and safety of workers, contractors and other users of the project area associated with industrial accidents, transportation accidents, shooting accidents and natural disasters would remain for the life of the project. However, these risks to the public would be small, given the remoteness of the area, the few visitors anticipated and the proposed mitigation measures.

4.15 NOISE

4.15.1 Introduction

Noise associated with the action alternatives would be caused by machinery used during drilling and construction of pipelines and access roads, construction and operation of ancillary facilities, and be heavy trucks and related equipment.

4.15.2 Impact Significance Criteria

The following criteria was used to assess the significance of noise impacts related to this project:

Long-term activities that would exceed federal 55dBA maximum standards for noise at either human or animal sensitive locations.

4.15.3 Direct and Indirect Impacts

4.15.3.1 Proposed Action

Noise levels associated with drilling, field development and operations activities may temporarily exceed the threshold EPA average 24-hour noise level of 55 dBA at specific locations within the ARPA, but the lack of year-round occupied human residences and the low level of non project-related human occupation of the project area would result in minimal noise impacts to persons other than project employees. Although noise impacts associated with compression facilities would be long term in duration, these same factors, lack of human residences and low human densities, would result in minimal compression facility noise impacts.

Implementation of the Proposed Action has the potential to create noise-generated impacts that emanate from machinery used during drilling and completion and during construction of drill sites, pipelines, access roads and ancillary facilities, and from the operation of heavy trucks and related equipment. During field operations, noise would be generated by compression facilities, pumper trucks, road maintenance equipment and well workover operations.

Noise associated with natural gas drilling, field development and field operations can affect human safety (at extreme levels) and comfort. Noise impacts can also modify animal behavior (see Section 4.7 for a discussion of the potential noise impacts to wildlife resources). The magnitude of noise impacts are contingent on a number of factors including the intensity and pitch of the source, air density, humidity, wind direction, screening/focusing by topography or vegetation, and distance to the observer. A variety of heavy equipment and machinery commonly used during drilling, field development and production operations generate noise levels in excess of the 55 dBA maximum standard. Noise impacts created by these activities are short-term, lasting as long as drilling, construction or field maintenance activities are performed at well sites, access roads, pipelines, and ancillary facilities. Under typical conditions, noise levels decline below the 55 dBA maximum standard at a relatively short distance (less than one mile from the source) depending on the factors outlined above.

Drilling, field development and field operations workers would be the only groups directly affected by Proposed Action-related noise disturbances for more than a brief period of time. These groups are subject to OSHA regulations regarding industrial noise protection. Grazing operators and recreation users of the area would typically be affected by noise impacts only for the brief period required to pass by sites where drilling, field development and field operations occur.

Natural gas compression facilities would be a source of long-term noise impacts. These impacts would exceed the 55 dBA maximum standard at the compression site, but noise levels would be attenuated to below acceptable levels a mile or less from the compression site. There are no year-round occupied residences located with in the ARPA and residences occupied occasionally (during livestock operations) are located on private land. Locations of compressor

stations would be determined in negotiations for surface use agreements. Therefore, field operations workers are likely to be the only group affected by compression noise for other than a brief period of time.

Based on the foregoing and the noise mitigation measures contained in Appendix E, Wildlife Mitigation and Monitoring Plan, noise impacts to the public associated with the Proposed Action would be minimal and short-term in nature.

4.15.3.2 Alternative A - No Action

Under this alternative there would be no noise related effects.

4.15.3.3 Alternative B

Under this alternative effects are anticipated to be generally the same as the Proposed Action. Focusing development into one area at a time would increase the intensity and extent of noise during the development period within the active zone, off-set by no noise or operational noise in other zones, depending on their status. Once construction and reclamation has ended within a zone operational noise associated with gas production activities would be the same as the Proposed Action.

4.15.3.4 Alternative C

Under this alternative effects are anticipated to be the same as the Proposed Action.

4.15.4 Additional Mitigation

In addition to the measures described in Appendix E, Wildlife Mitigation and Monitoring Plan, measures to mitigate noise impacts would include the following:

> In any area of operations (drill site, compressor site, etc.) where noise levels may exceed federal OSHA safe limits, the Operators and contractors would provide and require the use of proper personnel protective equipment by employees.

4.15.5 Residual Impacts

Although both intermittent (field maintenance and workover activities) and long-term (compression facilities) exceedences of 55 dBA noise levels would occur for the life of the project, the lack of year-round occupied human residences and the low human occupation of the project area would result in negligible noise impacts under the action alternatives. There would be no residual effects from the no action alternative.

4.16 WILD HORSES

As discussed in Chapter 3, no wild horses or designated wild horse management areas (HMAs) are within the ARPA. Therefore, potential impacts to wild horses from project-related activities do not exist and further discussion is not required.

CHAPTER 5

CUMULATIVE IMPACTS ANALYSIS

CHAPTER 5

CUMULATIVE IMPACTS ANALYSIS

5.1 INTRODUCTION

NEPA requires an assessment of potential cumulative impacts. Federal regulations (40 CFR 1500 - 1508) define cumulative impacts as:

> *"...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."*

Potential cumulative impacts are assessed at the resource level. The cumulative impact analysis (CIA) area for past, existing and reasonably foreseeable future activities (RFFAs) that may generate cumulative impacts varies depending on the resource under consideration. For example, the CIA area for air quality effects is regional in nature; therefore, the scope of activities considered is necessarily broad. In contrast, the CIA area for geology and minerals considers the project area associated with the proposed action and alternatives; therefore, the scope of potential cumulative activities considered is much narrower.

This discussion of potential cumulative impacts assumes the successful implementation of the environmental protection and mitigation measures discussed in Chapters 2 and 4 of this EIS as well as compliance with the Great Divide RMP and all applicable federal, state and local regulations and permit requirements. The analysis of cumulative impacts addresses both potential negative and positive impacts.

5.2 PAST, EXISTING AND REASONABLY FORESEEABLE FUTURE ACTIVITY

Past, existing and RFFAs are organized by CIA area and include the following:

5.2.1 Atlantic Rim Project Area

Historic and existing activities in the ARPA include cattle grazing, dispersed recreation and oil and gas exploration, development and production. Reasonably foreseeable future activities within the ARPA are the action alternatives and the No Action Alternative.

While additional natural gas proposals are possible, this analysis incorporates all reasonably foreseeable natural gas development activity within the project area based on current knowledge of the area's geology and natural gas drilling and development technology. Other potential developments such as coal mining, wind power development, hydropower, etc. are also possible. Such activities have not been proposed and therefore are not reasonably foreseeable. If these factors change and additional proposals are submitted, additional NEPA assessment (including cumulative impact analysis) would be required.

5.2.1.1 Disturbance within the Atlantic Rim Project Area

Previous existing disturbance within the ARPA is approximately 604 acres, and interim drilling disturbance is approximately 159 acres, for a total existing disturbance of 763 acres, or around 0.28 percent of the 270,000 acres comprising the project area. During the construction phase, the Proposed Action and Alternative B would disturb 15,800 acres. Under Alternative A (No-Action) no surface disturbance would occur. Under Alternative C construction disturbance would be approximately half of the proposed action, or 7,900 acres for 2.9% of the Project area. Disturbance areas within the ARPA would be reduced upon reclamation of pipeline ROWs and unused portions of drill pad and ancillary facility disturbances during the production phase for each alternative. Under the Proposed Action and Alternative B reclamation would reduce impacts to 6,240 acres for a cumulative impact of 7,003 acres or 2.6 percent of the ARPA. There would be no impacts to reduce under Alternative A (No-Action). For Alternative C reclamation would reduce disturbance to about 3,900 acres or 1.4 percent of the ARPA.

5.2.2 Southeastern Sweetwater County/Southwestern Carbon County CIA Area

Past and historic activities occurring in the area surrounding the Proposed Action include oil and gas exploration, development and production, dispersed recreation, ranching and grazing, and residential, commercial and industrial development in the communities of Rawlins, Wamsutter, and Baggs.

RFFAs in adjacent areas primarily involve natural gas development (Appendix M: Mineral Development Projects in the Vicinity). The Proposed Action is located in a region of intensive natural gas development. The projects and the NEPA documents from which potential cumulative impacts were obtained are listed below.

- The Desolation Flats Natural Gas Field Development Project Environmental Impact Statement (USDI-BLM 2003g) provided analysis associated with a maximum development of 385 natural gas wells at 361 locations, along with associated access roads, pipelines, and other ancillary facilities. The Desolation Flats Project Area encompasses 233,542 acres, located about 20 miles west of the ARPA. The Desolation Flats project area included two other EIS project areas with Records of Decision in effect, namely Mulligan Draw and Dripping Rock. These two areas were included in the Desolation Flats project area EIS to analyze the potential for increased well density.

- The Greater Wamsutter Area II (GWA II) Natural Gas Development Project Environmental Impact Statement (USDI-BLM 1995) provided an analysis of impacts associated with a maximum development pattern of 750 new production wells at 300 locations within the GWA II and associated access roads, pipelines, and other ancillary facilities. The GWA II analysis area is located to the northwest of the ARPA and includes approximately 334,191 acres.

  Development within the GWA II reached the levels analyzed in the EIS for that project (300 well locations). Directional drilling proved to be technically impractical or uneconomical in many areas within the GWA II project area, and additional well locations beyond those analyzed in the GWA II EIS were required to develop the anticipated 750 production wells. The expansion of development in the GWA II area and development in the Continental Divide area were combined in one analysis to make NEPA compliance more efficient and to facilitate the analysis of cumulative impacts.

- The Continental Divide/Wamsutter II Natural Gas Development Environmental Impact Statement (USDI-BLM 2000a) includes the Continental Divide area combined with the GWA II area. The combined project area is generally located in Townships 15 through 23 North, Ranges 91 through 99 West, in Sweetwater and Carbon counties, Wyoming. The total combined area encompasses approximately 1,061,200 acres. This project is located west of the ARPA.

The CD/WII EIS provides an assessment of environmental impacts associated with development of 3,000 natural gas wells. Based on that assessment, the BLM approved development of up to 2,130 wells, 50 percent on federal lands within the project area beginning in 1999 and continuing for approximately 20 years, with a project life of 30 to 50 years. Various associated facilities (e.g., roads, pipelines, power lines, water wells, disposal wells evaporation ponds, compressor stations, etc.) would also be constructed.

- Creston/Blue Gap Natural Gas Project Environmental Impact Statement (USDI-BLM 1994a) was approved on October 4, 1994, and provides an assessment of the environmental consequences of a proposed natural gas development project located immediately west of the ARPA. The BLM's decision allowed a maximum of 275 wells on 250 locations on a 160-acre spacing pattern. This natural gas development overlaps slightly on the ARPA's western edge.

- The Hay Reservoir Unit Natural Gas Development Environmental Assessment (USDI-BLM 2004) involved a natural gas producing area located northwest of the ARPA and GWA II. It analyzed impacts of an increase of up to 25 additional wells over three years, in addition to 44 existing wells.

- The South Baggs Area Natural Gas Development Project EIS (USDI-BLM 1999c) analyzed potential impacts of drilling 50 additional natural gas wells in the South Baggs area which is located south of the ARPA.

- The Vermillion Basin Natural Gas Exploration and Development Project Environmental Assessment (USDI-BLM 2000) analyzed potential impacts of drilling up to 56 wells in the 92,490-acre Vermillion Basin Project Area, located approximately 55 miles southwest of the ARPA.

5.2.3 Watershed CIA Area

Cumulative analysis of natural resources that relate to watershed function and stability should occur at the watershed level. Thus, the CIA area for soils, water resources, vegetation and wetlands includes two components: (1) an analysis of potential cumulative impacts within the ARPA, and (2) an analysis of potential cumulative impacts within watersheds that contain the ARPA.

The watershed area (Appendix M: Watershed Basins) considered in the CIA was defined following USDI-BLM (1994c) guidelines based on the USGS delineated watershed boundaries that contain or are adjacent to the ARPA. The ARPA falls predominantly within the Little Snake River drainage basin and the Great Divide drainage basin; however, a very small portion of the ARPA drains into Little Sage and Sugar Creeks, tributaries of the North Platte River. The total CIA area is approximately 6,913,642 acres in size. The CIA area includes the Creston/Blue Gap, Continental Divide/Wamsutter II, and South Baggs EIS study areas that fall entirely within the Little Snake River drainage and Great Divide basins.

5.2.3.1 Disturbance within the Watershed CIA Area

Cumulative disturbance within the watershed CIA area includes estimated disturbance associated with the Atlantic Rim project and existing and future disturbance associated with those portions of the Creston/Blue Gap, Continental Divide/Wamsutter II and South Baggs projects located within the Little Snake River and Great Divide drainage areas. No other permitted projects or RFFAs within the CIA area are reasonably foreseeable at this time.

The total existing and future disturbance in the watershed CIA area is estimated at approximately 14,343 acres.

5.2.4 Regional CIA Area

The regional perspective is useful primarily for the analysis of air quality and socioeconomic impacts. The south half of Wyoming, northern Colorado, and northeast Utah region includes extensive oil and gas development; grazing and ranching; recreational development and dispersed recreation use; coal and trona mining; soda ash, fertilizer and electric power production; and residential, commercial and industrial development. There are also several highways and Interstate 80 which must be considered in the analysis of cumulative air quality impacts.

5.3 POTENTIAL CUMULATIVE IMPACTS BY RESOURCE

5.3.1 Geology/Minerals/Paleontology

5.3.1.1 Geology and Minerals

With the exception of petroleum resources, the geology and mineral resources within the ARPA have not been significantly affected by present and existing activities and are not anticipated to be significantly affected by the Proposed Action or the No Action Alternative if mitigation measures specific to resources are adopted. Therefore no cumulative impacts are anticipated for geology or mineral resources other than oil and gas and potentially construction materials under the Proposed Action or the No Action Alternative. As discussed in Section 4.1, successful oil and gas and CBNG development would result in natural gas production and depletion which is the purpose of this proposal and not considered an adverse impact. Additionally, as discussed in that same section, construction grade materials are likely to be used from local sources for surfacing materials (gravel) for petroleum and CBNG facilities in the ARPA and other areas. If development is extensive, known accumulations of local materials may become depleted and additional sources would need to be identified and used.

5.3.1.2 Paleontology

Potential cumulative impacts to paleontology include cumulative loss of scientifically significant resources at both known and as yet undiscovered fossil localities. Fossil localities producing scientifically significant vertebrate fossils are rare and unevenly distributed through rocks that occur in the ARPA and adjacent areas of southern Wyoming. Those that yield fossils of great scientific importance are extremely rare. Several such localities are known from the ARPA and others may exist that have yet to be discovered within the ARPA as well as adjacent parts of southern Wyoming. These localities may preserve rare and scientifically significant fossils including remains of species not yet known to science or more complete specimens of known species. Loss of resources from such localities could be very significant.

The magnitude of the potential impact increases as additional oil and gas development projects are permitted in southwestern Wyoming on federal, state, and private lands that have not been evaluated for paleontology. Once a fossil locality producing significant resources is lost by excavation or buried it is effectively removed from the possibility of scientific study and that information is lost.

Cumulative beneficial consequences, including the recovery of scientifically significant fossil resources at known and as yet undiscovered fossil localities could occur anywhere in the project area. To be most beneficial, a mitigation plan for recovery and curation of newly discovered specimens and recording associated geologic data should be adopted.

5.3.2 Climate and Air Quality

The CALPUFF model was used to estimate the cumulative air quality impacts of NO_x, SO_2, PM_{10}, and $PM_{2.5}$ resulting from project sources, state-permitted sources, RFD, and RFFAs located within the model domain (Appendix M: Far-Field Modeling Domain and NEPA RFD Project Areas). Project source emissions are described and quantified in Section 4.2. State-permitted sources include NO_x, SO_2, and/or PM_{10}/$PM_{2.5}$ sources that began operation after January 1, 2001, and were permitted before March 31, 2004. Sources permitted within 18 months prior to January 1, 2001, but not yet operating were included as RFFAs. RFD was defined as the undeveloped portion of 1) an authorized NEPA project or 2) a proposed NEPA project for which quantified air emissions data were available at the time of the analysis. RFD Projects included in the cumulative analysis are listed in Table 5-1. State-permitted, RFFA, and RFD emission rates modeled in the cumulative analysis are shown in Section 4.2. While there may be additional gas processing and/or transmission requirements due to the development of this and other natural gas projects regionally and nationally, the potential effects of these developments are not quantified herein since these developments are speculative and would likely require additional WDEQ/AQD permitting if they eventually are proposed. A portion of the Powder River Basin Oil and Gas Development Project (PRBP), located approximately 68 miles (110 km) east-northeast of the ARPA, is located within the far-field modeling domain. A ratio of total PRBP field development equal to the geographical portion within the ARPA far-field modeling domain was included as RFD in this analysis. The PRBP identified significant project-specific and cumulative potential impacts in the Bridger Wilderness and other sensitive areas also analyzed for this project. Further information on potential air quality impacts associated with the PRBP may be found in the PRBP EIS prepared by BLM (2002b).

Cumulative potential impacts were analyzed at each of the nine Class I and sensitive Class II areas listed and at in-field locations within the ARPA. Ambient concentrations were estimated at each Class I and sensitive Class II area and at locations within the ARPA, and were compared to applicable ambient air quality standards and PSD increments. Atmospheric deposition calculations were performed for each Class I and sensitive Class II area and at acid-sensitive lakes within these areas. Cumulative deposition was used to compute ANC change which was compared to applicable LACs for each of the analyzed acid sensitive lakes. Total deposition impacts (cumulative impacts plus background) at Class I and sensitive Class II areas were compared to USFS levels of concern, 5 kg/ha-yr for S and 3 kg/ha-yr for N. Visibility (regional haze) potential impacts were computed for each Class I and sensitive Class II area. Potential changes in regional haze were estimated using CALPUFF modeled impacts and two sets of background visibility conditions, FLAG and IMPROVE, as described in Section 4.2. Potential changes to regional haze were compared to a 1.0 dv threshold.

Table 5-1. RFD Projects Included in Cumulative Analysis.

Big Piney-LaBarge	Little Greys River - MA 31
BTA Bravo	Lower Bush Creek CBM (Kennedy Oil)
Burley	Lower Greys River - MA 32
Burlington Little Monument	Moxa Arch
Cave Gulch	Mulligan Draw
Cliff Creek - USFS Management Area (MA) 22	Pacific Rim
Compressor Station, Pipeline- Williams	Pinedale Anticline Project
Continental Divide/Wamsutter II EIS	Piney Creeks - MA 26
Cooper Reservoir (1998)	Pioneer Gas Plant
Copper Ridge Shallow Gas Proj.	Powder River Basin
Cottonwood Creek - MA 25	Riley Ridge
Creston-Blue Gap	Road Hollow
Cutthroat Gas Processing Plant	Seminoe Road
Desolation Flats	Sierra Madre
Eighth Granger Gas Plant Expansion	Soda Unit
Fontenelle Natural Gas Infill Drilling	South Baggs
Ham's Fork Pipeline	South Piney
Hickey Mountain-Table Mountain	Stage Coach
Horse Creek - MA 24	Upper Hoback - MA 23
Horse Trap	Vermillion Basin
Jack Morrow Hills	Willow Creek - MA 49
Jonah Infill Drilling Project	Wind River (Bureau of Indian Affairs [BIA] lead agency)
LaBarge Creek – MA 12	

Proposed Action Far-Field Cumulative Impacts

Maximum potential cumulative impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ were estimated for each of the analyzed PSD Class I and sensitive PSD Class II areas. These potential impacts were added to ambient background pollutant concentrations for comparison to the WAAQS, CAAQS, and NAAQS. The predicted potential cumulative impacts are below applicable ambient air quality standards and PSD increments.

Potential visibility impacts are predicted to be above the "just noticeable visibility change" (1.0 dv) threshold at the Bridger Wilderness Area and Popo Agie Wilderness Area using the FLAG background visibility data and at Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area using the IMPROVE background visibility data. Potential visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

The maximum potential visibility impacts are primarily a result of the cumulative "non-project" regional source emissions. The maximum direct project potential visibility impacts (0.2 dv), as described in Section 4.2, were estimated to be less than the 1.0 dv threshold. In addition, as defined in the FLAG report, a 0.4 percent change in extinction (0.04 dv) is considered a Project specific significance level for cumulative visibility analyses. Specifically, if the direct Project contribution to a cumulative potential visibility impact of 1.0 dv or greater is less than 0.04 dv,

the project is regarded as having an insignificant contribution to the cumulative visibility impact. Additional analyses were performed following the FLAG report criteria for visibility significance determination. The results of this analysis indicated that for all days where the cumulative (project and regional sources) potential visibility impact was 1.0 dv or greater, the direct project potential impacts were below the 0.04 dv significance threshold. Based on these results, the Atlantic Rim project emissions would not cause or contribute to any visibility degradation at any of the Class I and sensitive Class II areas.

Potential cumulative atmospheric deposition impacts at the fourteen sensitive lakes are below the ANC change LACs. In addition, cumulative total N and S depositions are well below the 5-kg/ha-yr (S) and 3-kg/ha-yr (N) levels of concern.

Proposed Action In-Field Cumulative Impacts

Model predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ at locations within the ARPA resulting from Proposed Action and regional source emissions were added to monitored background concentrations and compared to ambient air quality standards. The estimated potential cumulative impacts from Project and regional sources were below applicable ambient air quality standards.

Alternative A – No Action Far-Field Cumulative Impacts

Initial Alternative A CALPUFF modeling performed and reported in the Technical Support Document assumed no field development within the ARPA beyond levels currently authorized. Later information received indicated that Alternative A would in fact include the development of 720 wells on state and private land within the ARPA. As a consequence, this Alternative as currently defined was not explicitly analyzed using the CALPUFF model. However, far-field CALPUFF modeling performed for the Proposed Action, which included emissions both from Project sources and from inventoried regional sources within the model study domain indicated that while Project sources contributed insignificantly to total far-field impacts, regional sources were the primary contributors to far-field impacts. Because the regional source inventory analyzed for the Proposed Action and Alternative A would have been identical, cumulative impacts analyzed for the Proposed Action are given as an upper bound of impacts which could occur under Alternative A. Total far-field impacts would be slightly less than those analyzed for the Proposed Action given the reduced number of wells developed.

Cumulative impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ from Proposed Action sources and inventoried regional sources within the model study domain, when added to ambient background pollutant concentrations, would be below applicable ambient air quality standards and PSD increments.

Potential cumulative visibility impacts analyzed for the Proposed Action are predicted to be above the "just noticeable visibility change" (1.0 dv) threshold at the Bridger Wilderness Area and Popo Agie Wilderness Area using FLAG background visibility data, and at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area using IMPROVE background visibility data. Potential visibility impacts from the Proposed Action at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

Potential cumulative atmospheric deposition impacts from the Proposed Action at the fourteen sensitive lakes would be below the ANC LACs. In addition, cumulative total N and S deposition would be below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern.

Alternative B –Far-Field Cumulative Impacts

The cumulative analysis performed for the Proposed Action modeled ARPA sources under a worst-case scenario, assuming one full year of construction in conjunction with nearly full-field development. Alternative B air emissions would be equal to or less than those which would occur under the maximum scenario analyzed for the Proposed Action. Furthermore, all other state-permitted sources, RFD, and RFFA would be identical to those analyzed for the Proposed Action and shown in Appendix M: Far-Field Modeling Domain and NEPA RFD Project Areas. Model results from the Proposed Action indicated that while Project sources contributed insignificantly to total far-field impacts, regional sources were the primary contributors to far-field impacts. As a result, Alternative B was not explicitly analyzed using the CALPUFF model and cumulative impacts analyzed for the Proposed Action are given as an upper bound of impacts which could occur under this Alternative. Total cumulative far-field impacts would be slightly less than those analyzed for the Proposed Action if additional air quality mitigation is implemented.

Cumulative impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ from Proposed Action sources and inventoried regional sources within the model study domain, when added to ambient background pollutant concentrations, would be below applicable ambient air quality standards and PSD increments. Potential cumulative visibility impacts analyzed for the Proposed Action are predicted to be above the "just noticeable visibility change" (1.0 dv) threshold at the Bridger Wilderness Area and Popo Agie Wilderness Area using FLAG background visibility data, and at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area using IMPROVE background visibility data. Potential cumulative visibility impacts from the Proposed Action at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days. Potential cumulative atmospheric deposition impacts from the Proposed Action at the fourteen sensitive lakes would be below the ANC LACs. In addition, cumulative total N and S deposition would be below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern.

Alternative C –Far-Field Cumulative Impacts

The cumulative analysis performed for the Proposed Action modeled ARPA sources under a worst-case scenario, assuming one full year of construction in conjunction with nearly full-field development. Alternative C air emissions would be equal to or less than those which would occur under the maximum scenario analyzed for the Proposed Action. Furthermore, all other state-permitted sources, RFD, and RFFA would be identical to those analyzed for the Proposed Action and shown in Appendix M: Far-Field Modeling Domain and NEPA RFD Project Areas. Model results from the Proposed Action indicated that while Project sources contributed insignificantly to total far-field impacts, regional sources were the primary contributors to far-field impacts. As a result, Alternative B was not explicitly analyzed using the CALPUFF model and cumulative impacts analyzed for the Proposed Action are given as an upper bound of impacts which could occur under this Alternative. Total cumulative far-field impacts would be slightly less than those analyzed for the Proposed Action if development rate limitations are imposed.

Cumulative impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ from Proposed Action sources and inventoried regional sources within the model study domain, when added to ambient

background pollutant concentrations, would be below applicable ambient air quality standards and PSD increments. Potential cumulative visibility impacts analyzed for the Proposed Action are predicted to be above the "just noticeable visibility change" (1.0 dv) threshold at the Bridger Wilderness Area and Popo Agie Wilderness Area using FLAG background visibility data, and at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area using IMPROVE background visibility data. Potential cumulative visibility impacts from the Proposed Action at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days. Potential cumulative atmospheric deposition impacts from the Proposed Action at the fourteen sensitive lakes would be below the ANC LACs. In addition, cumulative total N and S deposition would be below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern.

Unavoidable Adverse Impacts

Some increase in air pollutant emissions would occur as a result of the Proposed Action and regional source emissions. Near-field potential impacts from these emissions are predicted to be below applicable significance thresholds. However, there is a potential for cumulative visibility potential impacts to exceed visibility thresholds within PSD Class I Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area.

5.3.3 Soils

Existing and cumulative disturbances within the ARPA are described in Section 5.2.1.1 for the various alternatives. For all alternatives, the cumulative post-reclamation disturbances are relatively low, and the successful implementation of erosion, runoff, sediment control and revegetation measures described in Section 4.3 and the Reclamation Plan (Appendix B) would reduce the contribution of the Proposed Action or the Alternatives to cumulative impacts on soil resources. These would not remove the impact. Locally, there would still be areas exceeding the significance criteria which would be combined with those areas outside this project area which are also exceeding the significance criteria. New development adjacent to this project area would also contribute to the increased erosion and sedimentation within the watersheds. The action alternatives could add to the cumulative removal of biological soil crusts within the area. The cumulative impact on soil crusts can not be fully predicted due to the lack of inventory data. Initial reconnaissance has shown them to be scattered and mostly not well developed.

The ARPA contains such a small portion the North Platte River drainage that even cumulative impacts are insignificant. Erosion within the Great Divide Basin is generally low and site-specific due to terrain, and since there are no drainage outlets, it does not affect any other watersheds. However, the upper Colorado River drainage has listed both salinity and sediment as significant factors for many years. Water quality sampling in the 1980's documented the Muddy Creek drainage as the principle source of sediment for the upper Little Snake River. Conservation efforts over the last twenty years have achieved success in improving watershed cover and riparian health while reducing soil erosion, in part using 319 Clean Water funding from the EPA. These efforts have focused for the most part on livestock management; however, watershed assessments identified increased sedimentation due to oil and gas development (primarily due to runoff from roads). This project, along with other adjacent oil and gas development would only lead to increased accelerated erosion and exacerbate sedimentation (and salinity) issues within the upper Colorado River drainage.

5.3.4 Water Resources

Cumulative impacts include water resource impacts from ongoing activities, recently constructed projects, and projects likely to be implemented in the near future. Cumulative impacts are assessed for the ARPA and the watershed CIA area that includes the Little Snake River, the Great Divide and a very small part of the North Platte River drainage areas.

ARPA CIA Area: Existing and cumulative surface disturbances within the ARPA are described in Section 5.2.1.1 for all the alternatives.

Ranch management, grazing activities, and other resource uses within the EIS analysis area would be required to meet Standards for Healthy Rangelands (BLM, 1997) and therefore are not expected to have measurable effects to surface water resources. Since livestock tend to concentrate around stock ponds and in drainage areas in search of water, there would be localized effects to surface waters, which could lead to greater erosion where surface disturbance occurs and livestock concentration areas coincide.

Recreational activities like fishing, hunting and camping would continue to have minimal effects on surface water, but could be more pronounced in localized areas due to off-road travel and potential additional access provided by the project. Off-road travel in drainage areas will cause local effects to surface waters, but these effects would be limited in the EIS analysis area given restricted travel through the checkerboard federal and private ownership of many of the lands. Where there is continuous federal and the project improves or creates new access these impacts could be significant depending on the alternative selected.

No serious groundwater pollution problems have been detected in the watershed CIA area. Current oil and gas exploration and development activities must comply with federal and state environmental quality laws and thus, serious water quality and quantity impacts are not expected on a cumulative scale.

Watershed CIA Area:

Downstream demands for water in the Little Snake River drainage would continue to influence the water management in the basin. Additional reservoir construction and associated irrigation systems would most likely be constructed with regard to the Yampa River Basin Management Plan and the recovery program for Colorado River native fish downstream (http://www.r6.fws.gov/crrip/). In addition, regional surface water quality would continue to be influenced by local and regional land use trends and activities, which include ranching and farming, oil and gas exploration and development, coal mining (none currently planned), and recreational use. Irrigation activities and municipal water systems above and below the ARPPA would contribute additional salt loading into the Colorado River System.

Surface discharge at the Cow Creek Pod can be expected to continue through the life of the project according to the WYPDES permit # WY0042145 and #WY0035858 which allows for 1.34 tons/day and 180,600 gallons/day of total discharge under both permits. As described in chapter 3 and 4 this is an offset for an oil well (as defined by the Colorado River Salinity Control Forum) and the permit allows for the same volume of water and salt as was discharged by the oil well plugged (#1X-12). This discharge is into a reservoir on a tributary of Dry Cow Creek, this reservoir will be improved and maintained according to this use. The discharge permit is currently being revised to allow for water releases from the reservoir in a similar manner as what

occurred historically when #1X-12 was in operation. The permit has a point of compliance upstream of the confluence with Cow Creek that should not have water from the project.

This project does not propose any surface discharge of produced water from non-federal leases into facilities on private land. It is therefore assumed all water produced from the coal formation would be re-injected with the exception of off-set uses for flowing wells as described for Cow Creek. Therefore, the WYDEQ permit #WY0048437 for the Doty Mountain POD would not be used.

This project allows for closed system livestock or wildlife watering facilities under all alternatives subject to State permitting. Owners of any State-permitted water wells documented to be impacted by the project would be offered a well water agreement to mitigate any drawdown impacts.

Additional oil and gas exploration and development will occur in the areas within and surrounding the EIS analysis area. Cumulative post-reclamation disturbances would be a significant impact to surface water as discussed under Section 4.4. Combined impacts from the Creston Blue Gap area combined with the Atlantic Rim Project can be expected to change the surface runoff characteristics above background levels and would likely be detrimental to the Muddy Creek section west of Highway 789 listed as having threats on the State of Wyoming 303d list. Furthermore, salt and sediment contributions to Muddy Creek from these projects can be expected to increase above background levels due to surface disturbance and would impact the Colorado River Basin with the more conservative salt moving downstream and sediment stored in local channels with a portion contributing to the Little Snake River.

Current water usage in the general area of the ARPA from all combined surface water and groundwater sources is estimated to be approximately 90,000 ac-ft per year (Collentine et al. 1981). This estimate includes uses outside the watershed CIA. Using this estimate as an environmentally conservative indication of total existing water usage, the Atlantic Rim project under the Proposed Action (approximately 1,100 ac-ft), and because the Creston/Blue Gap, Continental Divide/Wamsutter II, and South Baggs project areas fall entirely within the Little Snake River and Great Divide Basins, 100 percent of the total water usage from these projects (approximately 2,700 ac-ft, 7,000 ac-ft, and 150 ac-ft, respectively) within the watershed CIA could be as much as 11,000 ac-ft over the life of the projects. If the total water usage from the Desolation Flats Project (approximately 900 ac-ft), even though its project area falls outside the watershed CIA, is also included, the total water usage for the general area could be as much as 12,000 ac-ft., or approximately 13 percent of the current water usage in the general area of the Atlantic Rim project. This cumulative water usage estimate is relatively small because it would be distributed over the lives of these projects, and for the ARPA much of the water use will be from coal formations, which are not connected to surface waters.

5.3.5 Vegetation and Wetlands

All the action alternatives would add to the cumulative removal of vegetation within the area. Because of the widespread distribution and abundance of the mountain and Wyoming big sagebrush cover types in the project area and south-central Wyoming, minor reductions in these upland cover types would not be a significant impact following successful reclamation and the long-term reestablishment and establishment of native shrubs. Vegetation cover types such as alkali sagebrush and silver sagebrush/bitterbrush could be significantly impacted by disturbance due to their low abundance across the region. Wildfires in this area occur infrequently and are usually of such small size that they add about 100 acres annually to the total amount of

disturbed vegetation. There has only been one large wildfire in the general area within the last 30 years, occurring in 1993 in the Sand Hills, which burned 2,900 acres. These areas recover quickly with herbaceous species, but more slowly with shrubs and trees. Prescribed burns have primarily occurred in mountain big sagebrush sites, and in limited cases in aspen, mountain big sagebrush/mountain shrub mix, and basin big sagebrush cover types. The timing and conditions at the time these treatments are executed are beneficial in terms of stimulating species to improve their health, or in the case of sagebrush reoccupy these habitats within 20 to 30 years. Future prescribed burns would need to factor other developments into both long-term objectives and the size and management of treatments, and would likely lead to more chemical and mechanical treatments.

The combination of activities that require reclamation and vegetation treatments increase the amount of vegetation that is dominated by herbaceous vegetation versus those dominated by shrubs. In general this would affect five to ten percent of the overall landscape. Recovery of habitat functionality for shrubs in treatments generally occurs within 30-50 years, whereas recovery of shrubs in reclamation tends to take longer. Since the majority of shrubland and woodland cover types consist of mature to overmature woody plants, increasing the amount of early succession, younger aged stands to diversify cover and age-class structure is desirable.

Indirect effects from the action alternatives would come from road issues of dust and desertification that increase in a cumulative manner with adjacent existing and proposed oil and gas development. Dust accumulation on vegetation, reduced photosynthetic activity and growth, and lower palatability for herbivores would result in long-term alteration of species composition, cover and productivity. If not mitigated, these impacts could affect 20-35 percent of the region and include all vegetation cover types. Desertification impacts from road modification of upland hydrology would also increase on a cumulative basis, but in more site specific areas. In generally flat to gently rolling terrain these impacts would be minimal, but in the Flattops, Powder Rim and Willow Creek areas results would be similar to ARPA with one-third or more of the country affected.

The invasion and establishment of invasive weed species has already resulted in an increase to the local and regional cumulative effects of undesirable plant species in native ecosystems. This project would contribute cumulatively to the local and regional invasive weed populations. An aggressive and constant-monitoring program by all involved parties (federal, state, and private), would be mandatory to contain or prevent this threat.

<u>Watershed CIA Area:</u> On the broader scale of watersheds, there would be negligible impacts to vegetation within the North Platte River drainage and minimal impacts to vegetation in the Great Divide Basin. Cumulative impacts in the upper Colorado River drainage would be low to moderate due to dust and desertification from roads and their influence on overland hydrology. These alterations would affect five to ten percent of the drainage within the upper Little Snake River and relate to long-term reduction of vegetative cover, species diversity and productivity, primarily in the Wyoming big sagebrush cover type. However, due to the wide range of this species, overall impacts would be low. The acreage of vegetation disturbance due to permitted activities and naturally occurring events would be less than 2 percent of the overall landscape.

Cumulative impacts also include wild horses in the Adobe Town HMA. Although not in the ARPA, this management area overlaps the southern portion of oil and gas field development west of Highway 789. Lack of funding for roundups led to population increases through 2002-03 resulting in forage consumption by wild horses equal to that normally consumed by wild horses and livestock combined. Because of concurrent drought conditions, species composition

decreased, vegetation cover decreased and plant spacing increased, which will require years to recover from. Roundups in 2003 and 2005 have returned wild horse numbers to desired levels, but if allowed to expand to the high numbers recently observed, it would have negative affects on reclamation, weeds, and erosion, in addition to the affects already described above.

5.3.6 Range Resources

In the long-term, cumulative impacts to the grazing resource would likely result in a small net loss in total annual forage production. This small decrease in quantity, assuming successful revegetation occurs, would be offset by an increase in quality that would be provided by a younger and more nutritious herbaceous cover. Although native shrubs would re-establish in the long-term, dominance of herbaceous vegetation would benefit livestock operations which currently run 90 percent cattle whose diets are primarily grasses. Dust impacts to vegetation, with lowered palatability and weight gains and health issues like dust pneumonia would tend to be larger issues than direct loss of vegetation. On a cumulative basis these impacts would increase, but the actual affect to each operation would depend on the operation size and how much of the operation was included within a development area. These impacts would occur in both the development and production phases of oil and gas development.

The more important impacts to grazing relate to disruptions to livestock management, damage to facilities, and death loss of animals to collisions and poisonous plants. The first two relate more to the development phase and can be minimized with adequate consultation. Unfortunately, the scope of this impact is not well understood by people or documented in terms of actual impact. For instance, in 2005, one operator had to roundup cattle three times rather than once from a 60,000 acre allotment and neighboring allotments due to pipeline construction and open fences. This increases labor costs, reduces weight gains, increases potential disease transmission, and reduces time available for other planned work. Animal death loss can occur at anytime, but can also be minimized with adherence to standard compliance stipulations. However, improved roads often just lead to greater vehicle speeds and potential for collisions. The weeds issue is more serious for sheep producers due to the death loss from halogeton. This invasive species has not been adequately controlled and is expanding with new disturbances, increasing sheep death loss and reducing the grazing land available that is free of halogeton. Whether this issue alone would eliminate economic sheep operations in this area is unknown, but currently this issue is the greatest threat to these operations.

In summary, impacts to livestock operations include the above factors, but the level of impact will be dependent on rate and extent of development upon each ranch. Development at a slower pace allows operators to keep up with what is happening and deal with problems as they arise. Development in one pasture or one allotment at a time still allows operators to work around development to minimize disruptions. However, the pace of development tends to be faster rather than slower, and 80 percent of the operators run entirely within oil and gas development areas, so there is no place else to go. Under this scenario, there is likely to be both reduced grazing use and in some cases suspension of grazing by the operator for up to five years during the development phase. Once field development is completed and the production phase begins, livestock grazing would likely return to initial levels of use.

<u>Watershed CIA Area</u>: Expanding the area for cumulative analysis of impacts to livestock operations does little to change the analysis above. If operators reduce their animal numbers, duration of use or suspend use to avoid disruptions due to oil and gas development, some additional grazing use could occur in areas not affected by this development. This could be in these watersheds or in others further distant. However, this would likely only be during the next

five to ten years and not continue once gas field operations became primarily production orientated.

As described above under Vegetation, the population of wild horses in the Adobe Town HMA could affect livestock operations under cumulative impacts with oil and gas development. If populations of wild horses are allowed to expand beyond desired population levels, flexibility of livestock operations to adjust to impacts from oil and gas development would be reduced. In the case of the 2003 and 2004 grazing seasons, nearly all summer livestock use was eliminated due to impacts from wild horses and the 2002 drought. If this situation reoccurs in conjunction with responding to management disruptions related to oil and gas development, additional reductions in livestock use may be required.

5.3.7 Wildlife

The CIA areas for wildlife resources differ with respect to species. This analysis examines the proportion of the wildlife habitat within respective CIA areas that may be disturbed from all past, present, and reasonably foreseeable future activities (RFFA). In assessing cumulative impacts, it was not possible to specifically determine where future impacts would occur within CIA areas. Therefore, estimates of total disturbance were made based upon the location of past, present, and known future projects within the CIA areas and the expected amount of disturbance associated with each project. The proportion of the estimated total disturbance within the CIA areas was used to estimate the cumulative area of wildlife habitats that may be disturbed by past, present, and RFFAs.

The cumulative indirect effects from the proposed action or alternatives to all wildlife species in general, would come from roads and traffic noise. As roads are developed within and adjacent to the project area, habitat is fragmented and roads serve as barriers to some animal movement. The displacement of species away from roadsides is cumulative in and of itself. Insects, birds, and amphibians all avoid dust and noise from roads which compounds impacts to adjacent habitats throughout the CIA area. Sagebrush obligate species would be affected by the cumulative removal of habitat (reduction or fragmentation of patch size and/or vertical habitat structure) throughout the area, mostly as a result of development in this and three adjacent EIS areas.

5.3.7.1 Big Game

Construction such as building well pads and roads can reduce use of surrounding habitat by wildlife. Although this construction reduces forage due to the direct loss of native vegetation, there is an area surrounding these sites that tends not to be utilized due to the increased human activity. This "zone" can extend up to a half mile from the construction area. Consequently, disturbance to wildlife can extend further offsite than the actual disturbed area. Some individual animals can "habituate" to the increased infrastructure; however, it is generally assumed that, overall, the increased human presence in an area is detrimental to big game species. Dust accumulation on vegetation lowers the palatability for big game; this along with the physical removal of vegetation reduces the availability of forage. The significance of this forage reduction is greater in big game crucial winter range, especially as development cumulatively and concurrently occurs outside the project area in adjacent oil and gas EIS areas.

Big game populations are managed within herd units designated for each species and cumulative impacts are discussed in the context of these areas. Cumulative big game habitat

losses for pronghorn, mule deer, and elk herds resulting from development of the ARPA, and adjacent EIS areas (Section 5.2.2) are presented in Table 5-2.

Implementation of the proposed project would affect crucial winter/yearlong and winter/yearlong range for all three big game species. The specific locations of future disturbances within the ARPA and the remainder of the herd units are not known; therefore the area of each type of seasonal big game ranges that may be impacted is unknown. Therefore, the potential impacts to big game habitats are estimated for the portions of each herd unit that contain designated big game seasonal ranges. The cumulative disturbance to big game seasonal ranges expected to result from development activities from the combination of existing, proposed, and reasonably foreseeable future surface disturbances for each of the three big game species are listed in Table 5-2. Cumulative impacts to big game would include permanent, short term and long term loss of habitat. In addition, it would also include such factors as increased stress due to human/wildlife encounters, potential reductions in birth/survival rates, and possible alterations of migration routes.

Pronghorn Cumulative impacts upon pronghorn migration routes are unknown at this time; however the current fencing along Highway 789 creates a barrier to pronghorn attempting to migrate across this highway.

It is assumed that most if not all of the Baggs herd transition range is located within the ARPA. The Baggs Herd Unit has 43.5% of its crucial winter range located within the ARPA. An additional 39.6% of this herd unit's crucial winter range lies within other oil and gas project EIS's boundaries adjacent to the ARPA. Therefore, 83.1% of the Baggs pronghorn crucial winter range may lie with one or more of several oil and gas project boundaries.

Mule Deer Cumulative impacts upon mule deer migration routes within the Baggs Herd Unit are unknown. Currently, a mule deer study is on going sponsored by industry. Upon completion of the first phase of the study, BLM and Game & Fish will have better information on migration routes. It is assumed that most if not all of this herd's transition range is located within the ARPA. The Baggs Herd Unit has 27% of its crucial winter range located within the ARPA. An additional 23.3% of this herd unit's crucial winter range lies within other oil and gas project EIS's boundaries adjacent to the ARPA. Therefore, 50.3% of the Baggs mule deer crucial winter range may lie with one or more of several oil and gas project boundaries.

Elk The Sierra Madre Herd Unit has 25% of its crucial winter range located within the ARPA. No additional acreage of this herd unit's crucial winter range lies within other oil and gas project EIS's boundaries adjacent to the ARPA. It is assumed that a portion of this herd's transition range is located along the eastern third of the ARPA. Current collaring studies within the ARPA by the Game & Fish show more movement of elk in a north / south direction along the eastern third of the ARPA than was originally suspected and that elk movement may not always be the most direct route from winter to summer range. It is likely that project activities will disturb elk to a degree that they may move to new areas outside the ARPA. This displacement could have consequences for livestock operators, and other wildlife habitat.

Table 5-2. Estimated Cumulative Surface Disturbance (acres) within Big Game Seasonal Ranges, Included within the ARPA.

		Project Related Development		Cumulative Development[1,2]		Total Disturbance
	Acreage Available	Initial	LOP	Existing	Potential Future	Acres
Pronghorn - Baggs Herd Unit						
Proposed Action	890,743	15,803	6,241	5,804	743	12,788
No Action (A)	890,743	0	0	5,804	743	6,547
Alternative B	890,743	15,803	6,241	5,804	743	12,788
Alternative C	890,743	7,902	2,247	5,804	743	8,794
Mule Deer - Baggs Herd Unit						
Proposed Action	1,843,543	15,803	6241	23,536	17,751	47,528
No Action (A)	1,843,543	0	0	23,536	17,751	41,287
Alternative B	1,843,543	15,803	6,241	23,536	17,751	47,528
Alternative C	1,843,543	7,902	2,247	23,536	17,751	43,534
Elk – Sierra Madre Herd Unit						
Proposed Action	1,525,644	15,803	6,241	883	0	7,124
No Action (A)	1,525,644	0	0	883	0	883
Alternative B	1,525,644	15,803	6,241	883	0	7,124
Alternative C	1,525,644	7,902	2,247	883	0	3,130

1 – Sources: Creston/Blue Gap EIS (USDI-BLM 1994), CD/WII EIS (USDI-BLM 2000a), Desolation Flats EIS (USDI-BLM 2003g); these numbers do not reflect acreage disturbed within the ARPA from existing natural gas development or the Interim Drilling Policy.
2 – Numbers reflect reclaimed acreage, not total shrub habitat loss as a result of the projects, therefore, the numbers are conservative.

5.3.7.2 Greater Sage-Grouse and Columbian Sharp-tailed Grouse

Greater sage-grouse inhabit the ARPA and surrounding area year-round and require a wide range of seasonal habitats. The ARPA is located primarily within the Sierra Madre Upland Game Bird Management Area (UGBMA), but a small section is also located in the Bitter Creek UGBMA. These two areas were used as the CIA area for greater sage-grouse breeding and nesting habitats.

There are a total of 185 greater sage-grouse leks (150 occupied, 14 unoccupied, and 21 unknown status) within the Bitter Creek and Sierra Madre UGBMAs. The area of potential nesting habitat consists of a 2-mile buffer placed around all occupied and unknown status leks within the Bitter Creek and Sierra Madre UGBMA. This area encompasses an additional 662,080 acres outside the ARPA, which is within EIS boundaries that have current, and could receive future, development.

There are 145 greater sage-grouse leks within a two mile buffer of all current EIS project boundaries for oil and gas development including the ARPA. This project would cumulatively increase the leks potentially impacted by 88 leks, or 160%. Furthermore, within the boundaries of the South Central Wyoming Sage Grouse Working Group Area (SCCA), 45% of this area's grouse are found within a two mile buffer of these same EIS boundaries and 28% are found within a two mile buffer of the ARPA. Data collected at seven sites in Wyoming documented 45% of nests occur within the two miles of a lek and that 64% of nests occur with three miles of a lek. In addition, nest success probability suggests increased nesting success rates beyond five miles of a lek (Holloran, 2005). Until all existing and suitable habitat is mapped within the ARPA beyond the two mile lek buffer there is a potential to have a significant direct and indirect impact to grouse. Within Wyoming, one of the greater sage-grouse's last strong holds remaining, nearly half of the leks found within the SCCA are within oil and gas fields being developed. Therefore, bird displacement and nest abandonment from direct and indirect impacts such as habitat fragmentation, dust, noise, human activities and long term loss of sagebrush habitat would be cumulatively significant, leading to lower productivity and a long-term decline in the population of this species.

Columbian sharp-tailed grouse inhabit the ARPA along the eastern edge and southern portions. The only populations found within Wyoming are within and adjacent to the ARPA. Wyoming's populations are a northern extension of those found within northwestern Colorado (133 leks). Currently, there are 27 leks in Wyoming, all of which occur on or within 16 miles of the east ARPA boundary. Only seven of these leks are afforded protection (BLM or Forest Service), the remaining 20 leks are found on state or private lands. Cumulative impacts to sharp-tailed grouse may occur from current and future county land use planning and community development, loss of CRP lands, mining and energy development in Colorado (Columbian Sharp-tailed Grouse Conservation Plan 2001). This development may cause bird displacement, nest abandonment from direct and indirect impacts such as habitat fragmentation, dust, noise, human activities and long term loss of mixed shrub habitat would be cumulatively significant. All of these impacts lead to lower productivity and long-term decline in the population of this species.

5.3.7.3 Raptors

The CIA area for raptors includes the ARPA plus a one-mile buffer. This area covers approximately 400,000 acres, all of which would be considered raptor foraging habitat. Approximately 290,000 acres of this area were located within one mile of a known raptor nest and are considered to be potential raptor nesting habitat.

Cumulative impacts from the creation of additional nesting sites (artificial nesting structures and tanks) are unknown from other conventional oil and gas EIS projects in the vicinity of the ARPA. In the CDWII EIS area, raptor nesting success is static to improving. In addition, raptor fledgling numbers increase from 3 per natural nest to 4 per artificial nest. Additional research is needed to evaluate impacts on raptors and their prey by creating additional nesting structures in areas that previously were limited by natural nesting substrates.

5.3.8 Special Status Plant, Wildlife, and Fish Species

Potential impacts to threatened, endangered, proposed and sensitive species in this area of Wyoming are likely to be primarily associated with minerals development (see Section 5.2.2). Sensitive Fish, described in Section 4.8, would be significantly impacted by the project. Since these populations are unique to this location, impacts would be cumulatively significant. Under

Alternative C, development protection measures would be applied to the Muddy Creek SMA and would effectively protect these fish populations. Implementation would extend the area over which potential development impacts would occur. However, the application of monitoring and mitigation measures associated with each of the projects within the CIA area is expected to provide adequate protection for threatened, endangered, proposed and candidate species from past, present and potential future actions under ESA. The implementation of the monitoring and mitigation measures would not apply to BLM sensitive species found on private and state surface lands (34% of the project area). Furthermore, those BLM sensitive species that have high site-fidelity, such as grouse and sagebrush obligate songbirds, would be affected. Therefore, impacts from this and other projects would be cumulatively significant leading to lower productivity and a long-term decline in the populations of these species.

5.3.9 Recreation Resources

The CIA area for recreation resources includes the ARPA, plus parts of southwestern Carbon County and southeastern Sweetwater County that generally lie in the area bounded by Rawlins, Creston Junction, Savery and Baggs, Wyoming. Existing mineral activities in this area include historical and ongoing oil and gas development, and proposed or reasonably foreseeable future oil and natural gas development.

Cumulative impacts to hunting, the main recreation activity in the CIA, would occur because of the extensive impacts of natural gas development on wildlife. The increased road density, traffic, noise and dust of development displace big game species (Wildlife, 3.7). When big game species leave an area, hunters soon leave as well, because hunting success declines. Wildlife and hunters have already been displaced by existing development in portions of the CIA. Displacement of game and hunters would occur in areas as they are developed. As development spreads, so does displacement. This could have a devastating financial effect on commercial big game outfitters that rely on wildlife and knowledge of the CIA for successful hunts. It would also tend to concentrate game and hunters in undeveloped adjacent areas, which would impact the quality and quantity of forage, and therefore the health of the animals. There would also be an increase the probability of hunting accidents due to increased hunter density in these adjacent undeveloped areas.

Relatively undisturbed scenery is an integral part of the recreation experience for many recreationists. The visual impacts of development would make the area increasingly undesirable for many hunters as development progresses. Activities such as wildlife viewing and mountain biking also tend to be scenery-dependent. Thus incremental increases in development have corresponding decreases in the desirability of the recreational setting.

Cumulative impacts would be greatest during the development phase in the ARPA, with the associated drill rigs, vehicles, human presence, noise and dust. Even after field development and interim reclamation are completed, the day to day maintenance of production operations would continue to displace much of the wildlife with noise, traffic, dust and habitat fragmentation. (Wildlife, 3.7) The area would still be undesirable for non-consumptive visitors such as sightseers, wildlife viewers, and mountain bikers because of the poor scenery cluttered with facilities and their associated network of roads. These visitors would be forced to travel elsewhere to find natural-appearing landscapes with the aesthetics they desire.

The establishment of mature vegetation after final reclamation would take 30 years in some parts of the ARPA. Localized areas may not successfully revegetate for much longer. The life of the project may be up to 50 years, so the ARPA is not likely to return to its predisturbance

wildlife habitat conditions for 70-80 years. Therefore, long-term cumulative impacts in the CIA would be significant because they are likely to affect at least two generations by making the area less desirable for hunters, wildlife viewers and other recreationists.

5.3.10 Visual Resources

The CIA area for visual resources includes the ARPA, plus parts of southwestern Carbon County and southeastern Sweetwater County that generally lie in the area bounded by Rawlins, Creston Junction, Savery and Baggs, Wyoming. Existing mineral activities in this area include historical and ongoing oil and gas development, and proposed or reasonably foreseeable future oil and natural gas development.

The action alternatives would increase the amount of visual resources in the CIA affected by historical, ongoing and reasonably foreseeable oil and gas development. Sixty-eight percent of the ARPA is visible from the Interstate, State, County, or BLM roads, so development of the ARPA would have a high visual impact on the CIA (Visual Resources 4.10). Incremental increases in development have corresponding decreases in the quality of visual resources in proximity to development.

Cumulative impacts would be significant because development in the CIA would exceed VRM Class III management objectives by dominating the view of the casual observer. The establishment of mature vegetation after final reclamation would take 30 years in some parts of the CIA. Localized areas may not successfully revegetate for much longer. The life of the project may be up to 50 years, so the CIA is not likely to return to its predisturbance character for up to 80 years.

5.3.11 Cultural Resources

The CIA area for cultural resources is the project area and adjacent areas in southeastern Sweetwater County and southwestern Carbon County (Appendix M: Chapter 5 – Cumulative Impacts Historic Trails). In examining the CIA which incorporates previous EIS areas west of the ARPA within the Rawlins Field Office boundary, it was found that approximately 65 total miles of historic trails (Overland, Cherokee, and Rawlins-Baggs Road) have been subjected to potential impacts from gas development. The ARPA includes approximately 73 miles of total historic trail segments.

Trails Eligible for the NRHP	Total Acres of Trails in CIA*	Total Acres of Trails in ARPA*	Percent of Increase in Potential Effects
Cherokee Trail	11,520	3,840	35%
Overland Trail	7,040	3,200	45%
Rawlins-Baggs Road	2,240	14,080	627%
Total	20,800	21,120	102%

*Calculations based on ¼ mile buffer either side of trails (i.e. ½ mile corridor).

The project area involves about 10 miles of the Overland, 12 miles of the Cherokee and 44 miles of the Rawlins-Baggs Road. All but about 7 miles of the total length of the Rawlins-Baggs Road is included within the ARPA.
Conclusions

While the potential for impacts to identified historic trails appear to increase significantly with the advent of the Atlantic Rim Project Area, it must be kept in mind that the identification of contributing segments has not been accomplished to date and the analysis above is very general as a result. Also, no attempt was made to assess potential impacts to setting because variables affecting the trail viewsheds are ambiguous. In other words, visibility analyses are conducted using the height of well pad facilities. The majority of well locations in the ARPA is proposed to be CBNG and will have surface facilities approximately 9 feet in height. The wells in the CIA are conventional gas which utilize surface facilities about 20 feet in height. Therefore, the differences in the types of surface facilities make the visibility analyses incompatible. Overall, it is expected that an increase of over 100% of impact potential would occur within the ARPA, largely due to the involvement of the Rawlins-Baggs Road.

5.3.12 Socioeconomic Resources

The CIA area for socioeconomic conditions includes western Carbon and eastern Sweetwater counties, and the communities of Rawlins, Baggs, Dixon and Wamsutter. Although Carbon and Sweetwater counties contain an abundance of oil, coal, uranium, trona and other resources, the current potential for cumulative socioeconomic effects in the CIA is associated with the pace and timing of development of the natural gas resources and the projects listed in Section 5.2.2. The pace of gas development depends in large part on national and global factors such as demand, supply, prices and production disruptions, and local factors such as transmission capacity, productivity of specific fields, rig and worker availability and individual company development strategies.

One of the key findings of a 2003 National Petroleum Council energy policy study was that "There has been a fundamental shift in the natural gas supply/demand balance that has resulted in higher prices and volatility in recent years. This situation is expected to continue, but can be moderated (NPC 2003)."

As a result of this volatility, predicting the pace of natural gas development in the CIA is difficult to do with certainty. The U.S. DOE Energy Information Administration (EIA) prepares an Annual Energy Outlook (AEO) that forecasts supply, demand and prices for a variety of energy commodities and analyzes the underlying trends for these forecasts. The 2005 AEO includes forecasts for natural gas national average wellhead prices that increase from the 2004 level or $4.98/MCF to $5.30 in 2005, and fall to $3.64 by 2010 (all estimates in $2003). The January 2005 Wyoming Consensus Revenue Estimating Group *Wyoming State Government Revenue Forecast* assumed that Wyoming natural gas average annual prices would fall from the 2004 level of $5.05/MCF to $4.75 in 2005 and $4.25 beyond 2005. During late fall and early summer of 2005 however, increased global demand and the effects of hurricane's Katrina and Rita drove natural gas prices at Wyoming hubs above $10/MCF. As a result, in October 2005 CREG issued new gas price forecasts of $7.00/MCF for 2005 and $6.00/ MCF for 2006 and beyond.

Based on anticipated gas demand and resultant high prices, the pace of drilling and field development in western Carbon County and eastern Sweetwater County is likely to increase. The rate of increase, at least in the near term, is likely to be constrained by the availability of

drilling rigs and qualified rig workers. However, sustained high gas prices would encourage construction of new rigs and attract workers to the drilling and field development trades. The time required for buildup of drilling and field development activity would provide an opportunity for development of housing resources and expansion of local government services. The overall increase in production-related tax revenues would also provide resources to expand local government services, at least at the county and special district levels.

Two interstate pipelines will be built through western Carbon County and eastern Sweetwater County in late 2005 and the first half of 2006; one is scheduled to be completed before the activity associated with the Atlantic Rim project would begin, but a portion of the compressor station construction phase for the Entrega pipeline may coincide with initiation of drilling and field development for the Atlantic Rim Project during late 2006. Completion of these pipelines could provide transportation to additional markets for locally produced gas, further accelerating the pace of development.

Assuming continued increases in drilling and field development activities over the next several years, potential cumulative impacts on area socioeconomic conditions would include positive effects on local economic conditions, increased employment opportunities associated with the Atlantic Rim project and the projects listed in Section 5.2.2, increased demand for temporary and long-term housing resources and community services from in-migrating employees associated with the projects, and increased federal, state and local tax and royalty revenues generated from gas development and production.

Increased housing and local government service demand from cumulative natural gas development would impact affected communities differently.

Both temporary and longer-term housing demand from substantial overall increases in drilling activity would likely exceed current housing resources in all communities in the assessment area during drilling and field development seasons. In Rawlins, vacant spaces in mobile home parks and available motel rooms could be absorbed although some currently dormant motels might be reopened, which would provide additional resources. In communities in the Little Snake River Valley and in Wamsutter, temporary housing resources are typically full during the annual drilling and field development seasons, although there is some turnover from time to time. Cumulative increases in demand for temporary housing resources would likely exceed current availability in these communities.

Deficits in temporary housing resources could be mitigated by the development of drilling and construction camps. One 80 person drilling camp with capacity to expand to 150 persons has been developed along WY 789 north of Dad and BP intends to develop a 400 person housing facility near Wamsutter. There are preliminary plans to develop other drilling camps in the area and to expand a mobile home/RV park in Wamsutter.

The pace of construction of new housing units in Rawlins, the LSRV and Wamsutter would need to increase substantially over current levels to accommodate cumulative demand for longer-term housing units. However, the development of substantial numbers of rig camp or construction camp units could free up spaces in mobile home parks, providing a resource for longer-term demand until the conventional housing market is able to respond.

Demands on most public facilities and services would be seasonal, and given the excess capacity in critical public facilities (water and sewer) in most communities, within capacity constraints. Because a large percentage of the workforce would be temporary, school

enrollment would not be anticipated to increase substantially and could likely be accommodated with the existing capacity of area schools, although Rawlins might need to add modular units at the elementary school until the new school is completed. Community services such as law enforcement, emergency response, social services and road and bridge departments would experience higher demand for service, particularly during drilling and field development seasons. However, given the levels of drilling that have occurred in recent years, county general funds and services funded by special district mill levies should see substantial increase in natural gas production-related revenues, which could be used to offset the costs of increases in service. In contrast, municipalities would receive few direct revenues from natural gas development and would likely face challenges in funding needed service increases to meet cumulative demand.

Cumulative development in the CIA also holds potential to affect local attitudes, opinions and lifestyles and these effects are likely to be mixed. Natural gas development in Carbon and Sweetwater counties would result in economic growth, increased employment opportunities in relatively high-paying jobs. Therefore the financial status of many residents of these counties is likely to improve, which would correspondingly increase support for cumulative development activities, particularly among those segments of the community which benefit directly or indirectly from the increased economic activity. On the other hand, those residents whose economic activities and/or recreation activities occupy the same areas as natural gas activities, such as ranchers, grazing operators, outfitters, hunters and other recreationists are among those most likely to be dissatisfied. Moreover, if area residents perceive that wildlife habitat and other resources are being degraded by gas development; levels of dissatisfaction could become greater and more widespread.

5.3.13 Transportation

The CIA for transportation includes the ARPA and the county roads and state and federal highways which provide access to the site.

Historic and existing traffic within the ARPA has been associated with grazing uses, recreation and oil and gas exploration and development. This traffic is considered to be minimal and seasonal in nature, and not anticipated to increase substantially. The Proposed Action and other Action Alternatives are the only RFFAs anticipated for the ARPA, therefore cumulative transportation impacts within the project area are anticipated to be similar to those attributable to the Proposed Action or other Action Alternatives.

The WYDOT projects increase in traffic on I-80 and WY 70. Table 5-3 displays WYDOT AADT projections for 2012 on these highways. Peak-year Proposed Action-related traffic would be less than one percent of 2012 traffic on I-80 at Creston Junction and about 7% on WY 70 west of Dixon. According to WYDOT, traffic on WY 789 is anticipated to decrease by 2012, and Proposed Action-related traffic would be an estimated 26 percent of WY 189 AADT at peak. With the addition of the incremental traffic assumed for the recently approved Desolation Flats project, incremental traffic on I-80 would be less than two percent of 2012 projected traffic, and incremental traffic on WY 789 would be below 30 percent of projected 2012 traffic. The Desolation Flats project's contribution to traffic on WY 70 is assumed to be negligible.

Table 5-3. Proposed Action Peak Drilling Year (Year 5) AADT Compared with 2002 AADT and 2012 Projected AADT on Affected Highways.

Highway	2002 AADT	Projected 2012 AADT	% Combined Atlantic Rim and Desolation Flats Traffic/ Projected 2012 AADT
I-80 (Junction WY 789)	11,760 (6,460 trucks)	15,000	2%
WY 789 (Creston Jct. - Baggs)	860 (210 trucks)	800	<30%
WY 70 (Dixon west)	480 (30 trucks)	550	8%

It should be noted that natural gas development-related increases in traffic on highways providing access to the ARPA are likely to peak over the next four to five years and begin declining before 2012. Cumulative natural gas-related traffic increases would be most evident on WY 789, a highway that is currently heavily used by gas field traffic. Although the cumulative gas field traffic would accelerate maintenance requirements on the highway and increase the probability of accidents, the State of Wyoming would receive substantial revenues from severance taxes and the state's share or federal mineral royalties which could offset maintenance costs.

5.3.14 Health and Safety

The area of analysis for potential cumulative impacts to health and safety is the ARPA. The Proposed Action and other Action Alternatives are the only RFFAs anticipated for the project area other than the existing grazing and recreation activities, therefore cumulative impacts to health and safety conditions are anticipated to be similar to those described for the direct and indirect impacts of the Proposed Action or other action alternatives.

5.3.15 Noise

The area for potential cumulative noise impacts is the ARPA. Existing sound disturbances within the ARPA are limited to those associated with grazing activities, dispersed recreation, aircraft flights and traffic on area roads and highways. The Proposed Action and other Action Alternatives are the only RFFAs anticipated for the ARPA that would create additional sound disturbance. Therefore cumulative noise impacts would be similar to those associated with the Proposed Action and other action alternatives.

CHAPTER 6

CONSULTATION AND COORDINATION

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6.0 CONSULTATION AND COORDINATION

An environmental impact statement (EIS) must be prepared when a federal government agency considers approving an action within its jurisdiction that may impact the human environment. An EIS aids federal officials in making decisions by presenting information on the physical, biological, and social environment of a proposed project and its alternatives. The first step in preparing an EIS is to determine the scope of the project, the range of action alternatives, and the impacts to be included in the document.

The Council on Environmental Quality (CEQ) regulations (40 CFR, Parts 1500-1508) require an early scoping process to determine the issues related to the proposed action and alternatives that the EIS should address. The purpose of the scoping process is to identify important issues, concerns, and potential impacts that require analysis in the EIS and to eliminate insignificant issues and alternatives from detailed analysis.

The Atlantic Rim Natural Gas Project EIS was prepared by a third party contractor working under the direction of and in cooperation with the lead agency for the project, which is the Bureau of Land Management (BLM), Rawlins Field Office, Rawlins, Wyoming.

6.1 PUBLIC PARTICIPATION

A Scoping Notice was prepared and submitted to the public by the BLM on June 25, 2001, requesting input into the proposed Atlantic Rim Natural Gas Field Development project. Scoping documents were sent out to the public listed on the BLM mailing list, as well as organizations, groups, and individuals requesting a copy of the scoping document. Public meetings to discuss the proposed project were conducted on July 10, 2001 in Baggs, Wyoming and on July 11, 2001 in Rawlins, Wyoming. There were 53 written responses received during the scoping period in response to this project. The issues and concerns identified by the public during the scoping period are summarized in Chapter 1.

During preparation of the EIS, the BLM and the consultant interdisciplinary team (IDT) have communicated with, and received or solicited input from various federal, State, county, and local agencies, elected representatives, environmental and citizens groups, industries, and individuals potentially concerned with issues regarding the proposed drilling action. The contacts made are summarized in the following sections.

The following organizations/individuals either provided comment or were provided the opportunity to comment during the scoping period.

CHAPTER 6: CONSULTATION AND COORDINATION

FEDERAL OFFICES

U.S. Bureau of Land Management, Wyoming State Office
U.S. Senator Mike Enzi
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Congresswoman Barbara Cubin
U.S. Senator Craig Thomas
U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service

STATE AGENCIES

Governor Jim Geringer
State Engineer's Office
State Senators
Wyoming Department of Environmental Quality
Wyoming Game and Fish Department
State Representatives
Wyoming State Planning Coordinator
Wyoming Department of Transportation
Wyoming Oil and Gas Conservation Commission

COUNTY GOVERNMENT

Carbon County Commissioners
Carbon County Planning Commission

MUNICIPALITIES

Mayor-Baggs
Mayor-Rawlins
Mayor-Wamsutter

NATIVE AMERICAN TRIBES

Northern Arapahoe Tribal Council
Ute Mountain Tribe
Shoshone-Arapahoe Joint Tribal Council
Shoshone Tribal Council
Ute Tribal Council
Uinta-Ouray Tribal Council

GRAZING PERMITTEES

Weber Ranch
Salisbury Livestock Company
Three Forks Ranch Corporation
Mike Sheehan
H.B. Lee
Espy Livestock
PH Livestock Company
Montgomery Livestock Company
Stratton Sheep Company
Sam Morgan
Robert Orchard
Matt Weber
Jack Creek Land and Cattle Company

LEASE AND ROW HOLDERS

Stone & Wolf, LLC
Merit Energy Company
Benson–Montin-Greer
North Finn, LLC
P&M Petroleum Management
KCS Mountain Resources, Inc.

LANDOWNERS

The scoping notice was sent to 111 landowners potentially affected by the proposal.

CHAPTER 6: CONSULTATION AND COORDINATION

LOCAL MEDIA

Casper Star-Tribune
Rock Springs Rocket Miner
Wyoming State Tribune/Eagle
KRAI - Craig, Colorado
KRKK - Rock Springs
KTWO - Casper
KUWR - University of Wyoming
Rawlins Daily Times
Wyoming State Journal
Gillette News-Record
KRAL - Rawlins
KSIT - Rock Springs
KTWO TV - Casper
Northwest Colorado Daily News

OTHER AGENCIES, INDUSTRY REPRENSENTATIVES, INDIVIDUALS, AND ORGANIZATIONS

Audubon Society
Wilderness Society
The Nature Conservancy
Field Museum of Natural History
Department of Geology
Montana Oil Journal
Murie Audubon Society
Petroleum Association of Wyoming
Sierra Club
Wyoming Outdoor Council
Wyoming Stockgrowers Association
Wyoming Woolgrowers Association
Ivan Herold
National Wildlife Federation
Carbon County Stockgrowers
Wyoming Association of Professional
Archaeologists
Independent Petroleum Association
of Mountain States
The Nature Conservancy
Rocky Mountain Oil & Gas Association
Wyoming Farm Bureau Federation
Wyoming Public Lands Council
Wyoming Wildlife Federation
Vern Brodsho
Little Snake River Conservation District

6.2 LIST OF PREPARERS

The following tables identify the BLM IDT (Table 6-1) and the consultant IDT (Table 6-2) that were principally involved with preparing this EIS.

Table 6-1. List of BLM Interdisciplinary Reviewers.

Name	Responsibility
RAWLINS FIELD OFFICE	
Missy Cook	Clerical and Environmental Coordination
Susan Foley	Soil Scientist
Nina Trapp	Cultural Resources
Dave Simons	Team Leader/NEPA Coordinator
Andy Warren	Range Resources
Bob Hartman	Petroleum Engineer
Mark Newman	Paleontology/Geology
Krystal Clair	Recreation and Visual Resources
Frank Blomquist	Wildlife/Fisheries, Special Status Species
Janelle Wrigley	Realty/Lands
Robert Lange	Hydrologist
Michael Bower	Fisheries Biologist
John Ahlbrandt	Natural Resource Specialist
WYOMING STATE OFFICE	
Susan Caplan	Air Quality
Janet Kurman	NEPA

Table 6-2. List of Consultant Interdisciplinary Team EIS Preparers.

Principal Interdisciplinary Team		
Name	**Affiliation**	**Responsibility**
Gary Holsan	Gary Holsan Environmental Planning	Interdisciplinary Team Leader, Project Manager
Larry Hayden-Wing	Hayden-Wing Associates	Wildlife/Fisheries, Special Status Animals and Fish
Larry Bennett	Hayden-Wing Associates	Soils, Vegetation and Wetlands, Special Status Plants, Reclamation
Ben Parkhurst	Hayden-Wing Associates	Fisheries Biologist
George Blankenship	Blankenship Consulting	Socioeconomics, Transportation, Health & Safety, Noise
Lloyd Levy	Lloyd Levy Consulting	Visual Resources and Recreation
Susan Connell Jim Zapert	TRC Environmental Corporation	Air Quality
Jana Pastor	Western Wyoming College	Cultural Resources
Gustav Winterfeld	Erathem-Vanir Geological Consultants	Geology, Paleontology, Mineral Resources
Charles Bucans	Star Valley Engineering, Inc.	Proposed Action/Coordination
Technical Support Team		
Travis Olson	Hayden-Wing Associates	Wildlife Biologist, GIS Specialist
Jeff Winstead	Hayden-Wing Associates	Cartographer, Wildlife Biologist
Connie Hedley	Hayden-Wing Associates	Document Assembly/Production

REFERENCES CITED

REFERENCES CITED

Adams, S. 2005, Landowner. Personal communication with George Blankenship, Blankenship Consulting LLC.. September 13.

Air Resource Specialists. (ARS). 2002. Green River Basin visibility study. Monitored air quality data. Air resource specialists, Fort Collins, Colorado.

Alldredge, A.W., and R.D. Deblinger. 1988. Great Divide Basin Pronghorn Study. Conducted for Minerals Company by Colorado State University. 137 pages.

Allen, J.D. and A.S. Flecker. 1993. Biodiversity conservation in running waters. BioScience 43:32-43.

Amrhein, C., J.E. Strong, and P.A. Mosher. 1992. Effect of deicing salts on metal and organic matter mobilization in roadside soils. Environmental Science & Technology 26:703-709.

Anderson, H.W. 1975. Relative contribution of sediment from source areas and transport processes. In: Proceedings, sediment-yield workshop; November 28-30; Oxford MS. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 66-73.

Angermeyer, P.L., A.P. Wheeler, and A.E. Rosenberger. 2004 A conceptual framework for assessing impacts of roads on aquatic biota. Fisheries 29(12):19-29.

Archer, D. L., L. R. Kaeding, B. D. Burdick, and C. W. McAda. 1985. A study of the endangered fishes of the upper Colorado River. Final report. Cooperative agreement 14-16-0006-82-959. U.S. Department of the Interior, Fish and Wildlife Service, Grand Junction, CO.

Archibald, J. D. 1993. The importance of phylogenetic analysis for the assessment of species turnover: a case history of Paleocene mammals in North America. Paleobiology. v. 19, p. 1-27.

Army Corps of Engineers (ACOE). 1987. Wetland delineation manual. Environmental Laboratory Tech. Rept. Y-87-1 (on-line version), U.S. Army Engineers Waterways Exp. Sta., Vicksburg, MS.

_____. (ACOE). 1992. Memorandum - clarification and interpretation of the 1987 manual, 6 March 1992, Dept. of Army, Washington, DC.

Ayers, R. S. and D. W. Westcot. 1985. Water quality for agriculture: FAO irrigation and drainage paper 29 Rev. 1. Food and Agriculture Organization of the United Nations, 174pp.

Baxter, G. T., and M. D. Stone. 1992. Amphibians and reptiles of Wyoming. Wyoming Game and Fish Department, Bulletin No. 16, Second Edition, Cheyenne, WY. 137pp.

_____. 1995. Fishes of Wyoming. Wyoming Game and Fish Department, 290pp.

Beatty, R. J. 2005. Catostomid spawning migrations and late-summer fish assemblages in lower Muddy Creek, an intermittent watershed in southern Carbon County, Wyoming. M.S. Thesis, Department of Zoology and Physiology, University of Wyoming, Laramie, Wyoming.

REFERENCES CITED

Beaumont, E. A. 1979. Depositional environments of Fort Union sediments (Tertiary, northwest Colorado) and their relation to coal. Amer. Assoc. Petrol. Geol. Bull. 63: 194-217.

Beauvais, G. P., D. Keinath, and J. Ratner. 2001. Habitat mapping and field surveys for lynx (*Lynx Canadensis*) on lands administered by the USDI-Bureau of Land Management in Wyoming. Wyoming Natural Diversity Database, Laramie, Wyoming. 11pp. plus appendices.

Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. Bethesda, MD. 275pp.

Belnap, J. K., J. Hilty, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological soil crusts: ecology and management. USDI-BLM Tech. Ref. 1730-2, Denver, CO.

Bentley, R. G., Jr., K.L. Eggleston, D. Price, E.R. Frandsen, and A.R. Dickerman. 1978. The effects of surface disturbance on the salinity of public lands in the Upper Colorado River Basin—1977 Status Report: USDI-BLM, 180pp.

Bettinger, R. L. and M. A. Baumhoff. 1982. The Numic spread: Great Basin Cultures in Competition. American Antiquity 47(3).

Biggins, D., B. Miller, B. Oakleaf, A. Farmer, R. Crete, and A. Dood. 1989. A system for evaluating black-footed ferret habitat: report prepared for the interstate coordinating committee. U.S. Department of the Interior, Fish and Wildlife Service; Wyoming Game and Fish Department; and Montana Department of Fish, Wildlife and Parks.

Binns, N. A. 1977. Present status of indigenous populations of cutthroat trout, *Salmo clarki*, in southwestern Wyoming. Fisheries Technical Bulletin No. 2. Wyoming Game and Fish Department, Cheyenne, WY. 58pp.

Blackstone, D. L. 1963. Unpublished mapping, 1:250,00 scale: in The Paleozoic History of Wyoming, Donald W. Boyd, ed. Memoir No. 5., The Geological Survey of Wyoming, 1993. p. 164-187.

Blankenship, T., PhD. 2002. Superintendent, Carbon County School District # 1. Personal communication with George Blankenship, Blankenship Consulting LLC. January 18.

Blodgett, M. 2003, 2004. Director, Rawlins Workforce Center, Wyoming Department of Workforce Services, Employment and Training Division. Personal communication with George Blankenship, Blankenship Consulting LLC. October 21, 2003. and September 20, 2004.

Bower, M.R. 2005. Distributions and habitat associations of bluehead suckers, flannelmouth suckers, and roundtail chubs in the upper Muddy Creek Watershed of Carbon County, Wyoming. M.S. Department of Zoology and Physiology, University of Wyoming.

Bowers, P. W., J. C. Miller, M. W. Bergstrom, L. L. Harrell, and A. D. Gardner. 1984. The Sheehan Site. Cultural Resource Management Report No. 20. Archaeological Services of Western Wyoming College, Rock Springs.

REFERENCES CITED

Bradley, W. H. 1964. Geology of Green River Formation and associated Eocene rocks in southwestern Wyoming and adjacent parts of Colorado and Utah. U.S. Geological Survey Professional Paper 496-A, A1-A86.

Braun, C. E., T. Britt, and R. O. Wallestad. 1977. Guidelines for maintenance of sage grouse habitats. Wildlife Society Bulletin 5:99-106.

Breithaupt, B. H. 1982. Paleontology and paleoecology of the Lance Formation (Maastrichtian), east flank Rock Springs Uplift, Sweetwater County, Wyoming. Contributions to Geology, v. 21., p. 123-151.

_____. 1985. Non-mammalian vertebrate faunas from the Late Cretaceous of Wyoming *in* Nelson, G. E. editor. Cretaceous of Wyoming, Wyoming Geological Association 36th annual field conference guidebook, p. 159-175.

Call, M. W. 1974. Habitat requirements and management recommendations for sage grouse. U.S. Department of the Interior, Bureau of Land Management Technical Note, Denver, CO. 37pp.

Call, M. W. and C. Maser. 1985. Wildlife in managed rangelands – the Great Basin of southeastern Oregon: sage grouse. USDA, Forest Service General Technical Report PNW-187.

Campbell, T. M., III, and T. W. Clark. 1981. Colony characteristics and vertebrate associates of white-tailed and black-tailed prairie dogs in Wyoming. American Midland Naturalist 105:269-275.

Carbon County Board of Commissioners and Carbon County Planning Commission. 1998. Carbon County land use plan, prepared by Pedersen Planning Consultants, Saratoga, Wyoming, approved June.

Carnes, S. 2000, 2002, 2003. Clerk, Town of Wamsutter. Personal communication with George Blankenship, Blankenship Consulting LLC. December 5, 2000; January 17, 2002; August 6, 2003.

Carrico, G. 2004. Outfitter and rancher. Rawlins, Wyoming. Personal communication with George Blankenship, Blankenship Consulting LLC. August 31, 2004.

Case, G. R. 1987. New selachian fauna from the late Campanian of Wyoming (Teapot Sandstone Member, Mesaverde Formation, Big Horn Basin). Palaeontographica. Abteilung A: Palaeozoologie-Stratigraphie, 1987. V. 197, Issue 1-3, pp. 1-37.

Case, J. C., and Larsen, L. L. 1991. Landslide map of the Rawlins 1° x 2° quadrangle. The Geological Survey of Wyoming, Open File Report 91-20, scale 1:250,000.

Case, J. C., L. L. Larsen, C.S. Boyd, and J.C. Cannia. 1994. Compilers. Earthquake epicenters and suspected active faults with surficial expression in Wyoming. The Geological Survey of Wyoming, scale 1:1,000,000.

REFERENCES CITED

Case, J. C., Edgar, T. V., and DeBruin, R. H. 2002. Subsidence potential related to water withdrawal in the Powder River Basin. http://www.wsgsweb.uwyo.edu/oilandgas/Subsidence.asp

City of Rawlins. 1998. Rawlins housing assessment, revised 1998. December 10.

Clair, K. 2003. Personal communication with Lloyd Levy, Lloyd Levy Consulting. October.

Clark, T. W., and M. R. Stromberg. 1987. Mammals in Wyoming. University of Kansas Museum of Natural History, Public Education Series No. 10. 313pp.

Clemens, W. A. 1966. Fossil mammals of the type Lance Formation, Wyoming. Part II. Marsupialia. University of California Publications in Geological Science, v. 62, 122pp.

Clemens, W. A., Lillegraven , J. A., Lindsay, E. H., and Simpson, G. G. 1979. Where, when, and what; a survey of known Mesozoic mammal distribution *in* Lillegraven, J. A., Kielan-Jawarowska, Z., and Clemens, W. A., editors. Mesozoic mammals; the first two-thirds of mammalian history, University of California Press, Berkeley, p. 7-58.

Clemens, W. A., and Lillegraven, J. A. 1986. New late Cretaceous, North American advanced therian mammals that fit neither the marsupial nor eutherian molds *in* Flanagan, Kathryn M., and Lillegraven, J. A., editors. Vertebrates, phylogeny, and philosophy, contributions to geology. University of Wyoming, Special Paper 3, p. 55-85.

Coates, D. A., and Heffern, E. L. 1999. Origin and geomorphology of clinker in the Powder River Basin, Wyoming and Montana: Wyoming Geological Association 50th Annual Field Conference Guidebook, p. 211-229.

Collentine, M., R. Libra, K. R. Feathers, and L. Hamden. 1981. Occurrence and characteristics of groundwater in the Great Divide and Washakie Basins, Wyoming. Vols. VI-A, B. Water Resources Research Institute, University of Wyoming, Laramie, WY. 163pp plus maps.

Colorado River Basin Salinity Control Forum. (CRBSCF). 1999. Water quality standards for salinity – Colorado River System, 1999 Review, June 1999.

Colorado Water Resources Research Institute. (CWRRI). 2000. http://www.waterknowledge.colostate.edu

Colson, J. 2000. Sheriff, Carbon County, WY. Personal communication with George Blankenship, Blankenship Consulting LLC. June 22, 2000.

_____. 2002. Sheriff, Carbon County, WY. Personal communication with George Blankenship, Blankenship Consulting LLC. January 25, 2002.

Connelly, J. W., and C. E. Braun. 1997. Long-term changes in sage grouse (Centrocercus urophasianus) populations in western North America. Wildlife Biology 3:229-234.

Cooperative Institute for Research in the Atmosphere. (CIRA). 2003. Interagency monitoring of protected visual environments (IMPROVE) summary data provided by Scott Copeland, Colorado State University, October 2003.

REFERENCES CITED

Corn, P. S., W. Stolzenburg, and L. J. Livo. 1989. Acid precipitation studies in Colorado and Wyoming: interim report of surveys of montane amphibians and water chemistry. Biological Reports 80(40.26): Air Pollution and Acid Rain Report Number 26. 57pp.

Cowardin, L. M., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. USDI-Fish and Wildlife Service. FWS/OBS-79/31. Washington, DC. (Available on the NWI website at http://wetlands.fws.gov/reports.htm

Creasman, S. D. and K. W. Thompson. 1988. Settlement and subsistence of the late prehistoric, Uinta phase, in the Green River Basin, Wyoming. Paper presented at the 46th Annual Plains Anthropological conference, Wichita, Kansas.

Creasman, S. D. and K. W. Thompson. 1997. Settlement and subsistence of the Archaic period in the Green River Basin, Wyoming *in* M. L. Larson and J. E. Francis, editors. Changing perspectives on the archaic of the northwestern plains. University of South Dakota Press, Vermillion.

Cronoble, J. M. 1969. South Baggs C west side canal gas field, Carbon County, Wyoming, and Moffat County, Colorado; p. 129-137 *in* Barlow, J. A. Jr., editor. Guidebook to Tertiary rocks of Wyoming. Wyo Geol. Assoc. 21st Annual Field Conf. Guidebook.

Cutter, W. L. 1958. Food habits of the swift fox in northern Texas. Journal of Mammalogy 39:527-532.

Deblinger, R.D. 1988. Ecology and behavior of pronghorn in the Red Desert, Wyoming, with reference to energy development. PhD. dissertation, Colorado State University, Fort Collins, Colorado. 227pp.

DeBruin, R. H. 1993. Overview of the oil and gas geology of Wyoming; pp. 837-873 *in* Snoke, A. W., Steidtmann, J. R., and S. M. Roberts editors. A geology of Wyoming.@ Wyo. Geol. Survey Memoir 5.

_____. 1996. Oil and gas map of Wyoming. Wyo. Geol. Survey map, MS-48.

DeBruin, R. H., and C. S. Boyd. 1991. Oil and gas map of Wyoming. Wyoming Geol. Survey Map, 35, scale 1:1,000,000.

DeGraaf, R. M., V. E. Scott, R. H. Hamre, L. Ernst, and S. H. Anderson. 1991. Forest and rangeland birds of the United States. U.S. Department of Agriculture Forest Service. Agriculture Handbook 688. 625pp.

Dinsmore, J. J. 1981. Mountain plovers, a synthesis of the literature and an annotated bibliography. 24pp.

_____. 1983. Mountain Plover (*Charadrius montanus*). Pages 185-196 *in* J.S. Armburster, editor. Impacts of coal surface mining on 25 migratory bird species of high federal interest. U.S. Department of the Interior, Fish and Wildlife Service Publication OBS-83/35, 348pp.

Dolan, L.S. and T.A. Wesche. 1987. Summary of Muddy Creek surface water and sediment transport data 1984-1986. Report to the Wyoming Water Research Center. 56 pp. *WWRC 87-28.*

Dorf, E. 1942. Upper Cretaceous floras of the Rocky Mountain region: II Flora of the Lance Formation at its type locality, Niobrara County, Wyoming. Carnegie Institute Washington, Publication 580, p. 79-159.

Driver, N. E., J. M. Norris, and G. Kuhn. 1984. Hydrology of area 53, northern Great Plains and Rocky Mountain coal provinces, Wyoming, Colorado, Idaho, and Utah. U.S. Geological Survey, WRI Open-File Report 83-765. Cheyenne, WY. 87pp.

Easterly, T., A. Wood, and T. Litchfield. 1991. Responses of pronghorn and mule deer to petroleum development on crucial winter range in the Rattlesnake Hills. Unpublished Completion Report. 67pp.

Edson, G. M. 1979. Preliminary geologic map and coal sections of the Seaverson Reservoir quadrangle, Carbon County, Wyoming. U.S. Geol. Survey Open-file Rept., p. 79-1577.

Energy Information Agency (EIA). 2001. Annual energy outlook 2001 with projections to 2020, December 2001, www.eia.doe.gov/oiaf/aeo/.

Englehart, J. 2000, 2002. Highland Enterprises. Personal communication with George Blankenship, Blankenship Consulting LLC. December 5, January 18.

Environmental Protection Agency (EPA), 1977a, Clean Water Act, Title IV - Permits and Licenses (Sections 401-406).

_____. (EPA). 1977b, Executive Order 11990 (Floodplains Protection), and the Protection of Wetlands, May 24, I977, 42 F.R. 26961.

Estes, R. 1964. Fossil vertebrates from the Late Cretaceous Lance Formation, eastern Wyoming. California University Publications in Geological Sciences. v. 49, 180pp.

Evans, B. 2002. Foreman, Carbon County Road and Bridge Department, Rawlins, WY. Personal communication with George Blankenship, Blankenship Consulting LLC. January 23.

Evans, D. L. 1983. Ferruginous hawk (*Buteo regalis*). Pages 109-123 *in* J. S. Armburster, editor. Impacts of coal surface mining on 25 migratory bird species of high federal interest. U.S. Department of the Interior, Fish and Wildlife Service FWS/OBS-83/85.

Fanning, E.J. 1986. Wyoming's Approach to Nonpoint Pollution Control. In Proceedings of Wyoming Water 1986 and Streamside Zone Conference – Wyoming's water doesn't wait while we debate, April 28-30, 1986, Casper, Wyoming. Sponsored by the Wyoming Water Research Center and UW Agriculture Extension Service, University of Wyoming. pp. 63-69. *WWRC 86-05n.*

Faure, G. 1986. Isotope geology. 2nd ed. John Wiley & Sons, 589pp.

Federal Register. 1978. Proposed critical habitat for the whooping crane. 43(160):36588-36590.

_____. 2003. Endangered and threatened wildlife and plants; withdrawal of the proposed rule to list the mountain plover as threatened. 68(174):53083-53101.

Fertig, W. 2000. Status review of the Ute ladies'-tresses in Wyoming. Report prepared for the Wyoming Cooperative Fish and Wildlife Research Unit, US Fish and Wildlife Service, and Wyoming Game and Fish Department by the Wyoming Natural Diversity Database, Laramie, WY.

_____. 2001. 2000 survey for blowout pentstemon (*Penstemon haydenii*) in Wyoming. A report prepared for the Bureau of Land Management Wyoming State Office. Wyoming Natural Diversity Database, University of Wyoming, Laramie.

Fisser, H. G. 1987. Wyoming shrubland ecology. Wy. Ag. Exp. Sta. Science Monograph 49. Laramie, WY.

Fletcher, P. K., D. E. Fletcher, and L. Whitley. 1999. Cherokee trail diaries. Caxton Printers, Ltd., Caldwell, ID.

Forman, R.T.T., and L.E. Alexander. 1998. Roads and their Major Ecological Effects. Annu. Rev. Ecolo. Syst. 29:207-231

Freethey, G. W. 1987. Upper Colorado river basin regional aquifer systems analysis-Mesozoic rock in Colorado, Utah, Wyoming, Arizona, and New Mexico, p. 57-70, *in* J. S. McLean and A. I. Johnson, editors. Regional aquifer systems of the United States: aquifers of the western mountain area. Amer. Water Res. Assoc. Mono. Ser. No. 14. 23rd Annual AWRA Conference and Symposium, Nov. 1-6, 11987, Salt Lake City, UT. 229pp.

Freeze, R. A., and Cherry, J. A. 1979. Groundwater: Prentice-Hall, Inc., New Jersey, 604pp.

Gardner, A. D., D. Allen and M. Allen. 1993. The Washakie Stage Station and surrounding environment 1849-1860. Prepared for the Rawlins District, Bureau of Land Management. Archaeological Services of Western Wyoming College, Rock Springs.

Gibson, R.J., R.L. Haedrich, and C.M. Wernerheim. 2005. Loss of fish habitat as a consequence of inappropriately constructed stream crossings. Fisheries 30(1):10-17.

Giesen, K. M. and J. W. Connelly. 1993. Guidelines for management of Columbian sharp-tailed grouse habitats. Wildl. Soc. Bull. 21:325-333.

Gill, J. R., Merewether, E. A., and W. A. Cobban. 1970. Stratigraphy and nomenclature of some Upper Cretaceous and lower Tertiary rocks in south-central Wyoming. U.S. Geol. Survey Prof. Paper 667: 53pp.

Goetler, C. M. 1992. Sediment dynamics within channel and riparian zone types along a cold-desert Wyoming stream. M.S. Thesis, University of Wyoming, Laramie, Wyoming.

Goodrich, S., E. D. McArthur, and A. H. Winward. 1985. A new combination and a new variety in *Artemesia tridentata*. Great Basin Naturalist 45:99-104.

Goodrich, S., D. Nelson, and N. Gale. 1999. Some features of Wyoming big sagebrush communities on gravel pediments of the Green River in Daggett County, Utah, pp. 159-167 *in* D. E, McArthur, W. K. Otler, D. L. Wambolt compilers. Shrubland ecotones, USDA For. Serv. Proc. RMRS-P-11.

Goodrick, S. 2000. Class III cultural resource inventory for the petroleum development corporation Dry Cow Creek Pod. Prepared for Holsan Environmental Planning. Western Archaeological Services, Rock Springs.

Graf, W.L. 1978. Fluvial adjustments to the spread of tamarisk in the Colorado Plateau region. Geological Society of American Bulletin 89:1491-1501.

Gregory, R. W., and R. H. DeBruin. 1991. Oil and gas fields map of the greater Green River Basin and overthrust belt, southwestern Wyoming. Wyoming Geol. Survey Map, 36.

Grieve, P. 2000, 2002, 2003. Western United Realty, Baggs, WY. Personal communication with George Blankenship, Blankenship Consulting LLC. December 6, January 17, August 6.

Hall, D. H. 1987. Archaeological investigations within the Little Snake River basin, Colorado and Wyoming.. Master's Thesis on file. Submitted to the Department of Anthropology, Colorado State University, Fort Collins, Colorado.

Hall, E. R. and K. R. Kelson. 1959. The mammals of North America. The Ronald Press Company, New York. 1083pp.

Harrell, L. 1989. The Buffalo Hump site: late prehistoric dwellings in the Great Basin, Wyoming. Cultural Resource Management Report No. 37. Archaeological Services of Western Wyoming College, Rock Springs.

Harris, R. E., W. D. Hausel, and J. E. Meyer. 1985. Metallic and industrial minerals map of Wyoming. The Geological Survey of Wyoming, Map Series 14, scale 1:500,000.

Harris, R. E., and J. K. King. 1993. Geologic classification and origin of radioactive mineralization in Wyoming; pp. 899-916 *in* Snoke, A. W., Steidtmann, J. R., and S. M. Roberts editors. A geology of Wyoming.@ Wyo. Geol. Survey Memoir 5.

Harris, R. E. 1996. Industrial minerals and construction materials map of Wyoming. Wyo. Geol. Survey Map, MS-47.

Hartman, R. L., and B. E. Nelson. 2000. Working list of invasive vascular plants of Wyoming. (http://www.mh.uwyo.edu)

Hawkins, M. 2000. Drifter's Inn Motel, Baggs, WY. Personal communication with George Blankenship, Blankenship Consulting LLC, Denver, CO. June 26.

Hayden-Wing Associates (HWA). 2000a. Black-footed ferret surveys, Atlantic Rim's Dry Cow Creek Pod, Carbon County, Wyoming.

_____. (HWA). 2000b. Black-footed ferret surveys Atlantic Rim Sun Dog POD, Carbon County, Wyoming.

_____. (HWA). 2001a. Black-footed ferret surveys Atlantic Rim Sun Dog POD, Carbon County, Wyoming September 9-14, 2001. Report prepared for PEDCO and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming, September 2001.

_____. (HWA). 2001b. Black-footed ferret survey results on the Atlantic Rim Blue Sky POD August, 16-18, 2001. Report prepared for PEDCO and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming, August 2001.

_____. (HWA). 2002a. Black-footed ferret survey results on the Atlantic Rim Blue Sky POD September 18-20, 2002. Report prepared for PEDCO and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming, September 2002.

_____. (HWA). 2002b. Black-footed ferret survey results on the Cow Creek Seismic Project Atlantic Rim Coalbed Methane EIS Project Area July 22-24, 2002. Report prepared for Double Eagle and the Bureau of Land Management, Rawlins Field Office by Hayden-Wing Associates, Laramie, Wyoming, July 2002.

_____. (HWA). 2004. Vegetation and habitat analysis of critical wintering areas for greater sage-grouse. Final Report. Laramie, Wyoming. 45pp.

Hayden-Wing, L. D., D. B. Costain, J. L. Hull, M. R. Jackson, and T. B. Segerstrom. 1986. Movement patterns and habitat affinities of a sage grouse population in northeastern Wyoming. Pages 207-226 *in* R. D. Commer, T. G. Bauman, P. Davis, J. W. Monarch, J. Todd, S. Van Gytenbeek, D. Wills, and J. Woodling editors. Proceedings for issues and tecnnology in the management of impacts on western wildlands. Glenwood Springs, CO. Feb 4-6, 1985.

Heath, R. C. 1984. Groundwater regions of the United States. U.S. Geological Survey Water-Supply Paper 2242. U.S. Government Printing Office, Washington, D.C. 78pp.

Hem, J. D. 1970. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water-Supply Paper 1473. U.S. Government Printing Office, Washington, D.C. 363 pp.

Herold, R. 2000. Baggs Medical Clinic. Personal communication with George Blankenship, Blankenship Consulting LLC. June 22.

_____. 2005. Town Clerk< Town of Baggs. Personal communication with George Blankenship, Blankenship Consulting LLC. September 13.

Hettinger, R. D., and R. Brown. 1979. Geophysical and lithologic logs of 1977 coal drilling in the Fort Union Formation, Carbon and Sweetwater Counties, Wyoming. U.S. Geol. Survey Open-file Rept., 79-326: 81pp.

Hettinger, R. D., Honey, J. G., and D. J. Nichols. 1991. Chart showing correlations of Upper Cretaceous Fox Hills Sandstone and Lance Formation, and lower Tertiary Fort Union, Wasatch, and Green River Formations, from the eastern flank of the Washakie Basin to the southeastern part of the Great Divide Basin, Wyoming. U.S. Geol. Survey Misc. Inv. Map I-2151.

Hettinger, R. D., and M. A. Kirschbaum. 1991. Chart showing correlations of some Upper Cretaceous and lower Tertiary rocks, from the east flank of the Washakie Basin to the east flank of the Rock Springs Uplift, Wyoming. U.S. Geol. Surv. Misc. Inv. Map, I-2152.

Hewitt, H. 2001. Carbon County Planning Commission, Coldwell Banker Hewitt and Associates. Personal communication with George Blankenship, Blankenship Consulting LLC. August 23.

Hiatt, K. 2000. Rawlins - Carbon County Chamber of Commerce. Personal communication with George Blankenship, Blankenship Consulting LLC. June 22.

Hicks, L. and A. Warren. 1992. Muddy Creek Seeking Common Ground Project. Little Snake River Conservation District, Baggs, Wyoming.

Hicks, L. and A. Warren. 1997. Muddy Creek Seeking Common Ground Project. In Proceedings of Wyoming Water 1997 – What's new in the toolbox? April 21-23, 1997, Casper, Wyoming. Sponsored by the Wyoming Water Resource Center, University of Wyoming, pp. 12-14. *WWRC 97-05d.*

Hicks, L., A. Warren and C. Hicks. 1996. Upper Muddy Creek Coordinated Resource Management. Symposium proceedings: Sharing common ground on western rangelands, Sparks, Nevada.

Hightree, N. 2002. Emergency Medical Technician, Memorial Hospital of Carbon County. Personal communication with George Blankenship, Blankenship Consulting LLC. January 25.

Hoefer, T., III, S. D. Creasman, D. Murcray, and J. Bozovich. 1992. The South Baxter brush shelter site: an early Shoshonean occupation in southwestern Wyoming. The Wyoming Archaeologist 36(3-4).

Hoffman, R.W. (Technical Editor) 2001. Northwest Colorado Columbian sharp-tailed grouse conservation plan. Northwest Colorado Columbian sharp-tailed Grouse Work Group and Colorado Division of Wildlife, Fort Collins, Colorado.

Holloran, M.J. and S.H. Anderson. 2005. Spatial Distribution of Greater Sage-grouse nest in Relatively Contiguous Sagebrush Habitats.

Honey, J. G,. 1988. A mammalian fauna from the base of the Eocene Cathedral Bluffs Tongue of the Wasatch Formation, Cottonwood Creek area, Southeast Washakie Basin, Wyoming *in* Roehler, H. W., J. H. Hanley, and J. G. Honey, Geology and paleoecology of the Cottonwood Creek delta in the Eocene Tipton Tongue of the Green River Formation and a mammalian fauna from the Eocene Cathedral Bluffs Tongue of the Wasatch Formation, Southeast Washakie Basin, Wyoming. US Geological Survey Professional Paper 1669, p. 1-14

Honey, J. G., and R. D. Hettinger. 1989. Stratigraphic sections showing coal correlations within the lower coal zone of the Paleocene Fort Union Formation, Fillmore Ranch and Seaverson Reservoir Quadrangles, Carbon County, Wyoming. U.S. Geol. Survey Coal Inv. Map, C-127.

Honey, J. G., and L. N. Roberts. 1989. Stratigraphic sections showing coal correlations within the lower part of the Fort Union Formation in the Baggs area, Carbon County, Wyoming. U.S. Geological Survey Coal Inv. Map, C-135.

Honey, J. G. 1990. Stratigraphic sections showing coal correlations within the lower coal zone of the Paleocene Fort Union Formation, Riner Quadrangle, Carbon and Sweetwater Counties, Wyoming. U.S. Geol. Survey Coal Inv. Map, C-125.

Honey, J. G. 2003. Personal communication with Thomas M. Bown on paleontology localities within the Atlantic Rim and adjacent areas.

Hydro-Search, Inc. (HSI), 1981. Water Resources Investigation of the Atlantic Rim Project Area, prepared for Rocky Mountain Energy. Reno/Denver.

Irby, L.R., R.J. Mackie, H.I. Pac, and W.F. Kasworm. 1988. Management of mule deer in relation to oil and gas development in Montana's overthrust belt. Pages 113-121 *In* J. Emerick et al., editors. Proceedings III: Issues and technology in the management of impacted wildlife. Thorne Ecological Institute, Boulder, Colorado.

Johnsgard, P. A. 1986. Birds of the Rocky Mountains. Colorado University Press, Boulder, CO. 504pp.

Justensen, L. 2001. Supervisor, Carbon County Weed and Pest District. Personal conversation with Larry E. Bennett, Hayden-Wing Associates, 29 November 2001.

Kaiser, W. R., Scott, A. R., Hamilton, D. S., Tyler, R., McMurry, R. G., Zhou, N., and C. M. Tremain. 1994. Geologic and hydrologic controls on coalbed methane: Sand Wash Basin, Colorado and Wyoming. Colo. Geol. Survey Resource Series 30/Bur. Econ. Geol. Rept. Invest., No. 220.

Kantrud, H. A. and R. Kologiski. 1982. Effects of soils and grazing on breeding birds of uncultivated upland grasslands of the northern Great Plains. Wildlife Research Report 15. 9pp.

Kilgore, R. 2002, 2003, 2005. Community Development Director, City of Rawlins. Personal communication with George Blankenship, Blankenship Consulting LLC. January 9, October 27 and September 13.

Latham, M. A. 1999. Class III cultural resource inventory and evaluation of eleven prehistoric sites: Little Snake supplemental irrigation water supply poject, High Savery Dam and Reservoir alternative, Carbon County, Wyoming. Burns and McDonnell.

Larson, L.R. and Everett A. Zimmerman. 1981. Water resources of upper Separation Creek Basin, south-central Wyoming. U.S. Geological Survey Water Resources Investigations 80-85.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. 1980. Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh, N.C. 867pp.

Lillegraven, J. A., and McKenna, M. C. 1986. Fossil mammals from the "Mesaverde" Formation (Late Cretaceous, Judithian) of the Bighorn and Wind River Basins, Wyoming, with definitions of late Cretaceous North American land-mammal "ages". American Museum Novitates, v. 2840, 68pp.

Lillegraven, J.A. 2002. Personal communication to Gustav F. Winterfeld.

Lowham, H. W., L.L. DeLong, K.R. Collier, and E.A. Zimmerman. 1982. Hydrology of Salt Wells Creek—a plains stream in southwestern Wyoming. U.S. Geological Survey Water-Resources Investigations 81-62.

Lowham, H. W., L.L. DeLong, K.D. Peter, D.J. Wangsness, W.J. Head, and B.H. Ringen. 1976. A plan for study of water and its relation to economic development in the Green River and Great Divide Basins in Wyoming. U.S. Geological Survey Open File Report 76-349.

Love, J.D. 1970. Cenozoic geology of the Granite Mountains area, central Wyoming. U.S. Geological Survey Professional Paper 495-C, 154pp.

Love, J. D. and A.C. Christiansen. 1985. Compilers. Geologic map of Wyoming. U.S. Geologic Survey Map, scale 1:500,000.

Love, J.D., A.C. Christiansen, and A.J. Ver Ploeg. 1993. Compilers. Stratigraphic chart showing Phanerozoic nomenclature for the State of Wyoming. The Geological Survey of Wyoming. Map Series 41.

Lyman, R. N. and Volkmer, J. E. 2001. Pyrophoricity (spontaneous combustion) of Powder River Basin coals–considerations for coalbed methane development http://www.wsgsweb.uwyo.edu/Coal/CR01-1.pdf

MacDonald, M.G., and A.W. Harbaugh, 1988, A Modular Three-Dimensional Finite Difference Ground-Water Flow Model: U.S. Geological Survey Techniques of Water Resources Investigations Report 88-4046, 201p.

Maddux, H. R., and W. G. Kepner. 1988. Spawning of bluehead sucker in Kanab Creek, Arizona (Pisces: Catastomidae). Southwest Naturalist. 33:364-365.

Malm, W.C. 2000. Spatial and seasonal patterns and temporal variability of haze and its constituents in the United States, Report III, Cooperative Institute for Research in the Atmosphere, Colorado State University, ISSN 0737-5352-47.

Manning, R.E. 1986. Studies in outdoor recreation: a review and synthesis of the social science literature in outdoor recreation, Oregon State University Press, Corvallis, OR.

Martin, J. W. and B. A. Carlson. 1998. Sage Sparrow (*Amphispiza belli*) *in* The birds of North America, No. 326. A. Poole and F. Gill (eds.). The Birds of North America, Inc., Philadelphia, PA.

Martner, B. E. 1986. Wyoming climate atlas. University of Nebraska Press, Lincoln, NE.

Masursky, H. 1962. Uranium-bearing coal in the eastern part of the Red Desert area, Great Divide Basin, Sweetwater County, Wyoming. U.S. Geol. Survey Bull., 1099-B:152pp.

McGrew, P.O. 1951. Tertiary stratigraphy and paleontology of south central Wyoming. Wyoming Geological Association, Sixth annual field Conference Guidebook, p 54-57.

______. 1976. Class notes on Cenozoic stratigraphy. Department of Geology, University of Wyoming.

McKee, J. E. and H. W. Wolf, editors. 1963. Water quality criteria, 2nd edition, prepared with assistance from the Division of Water Supply and Pollution Control, US Public Health Service, Department of Health, Education, and Welfare.

Merewether, E. A. 1971. Geologic map of the Wild Horse Mountain Quadrangle, Carbon County, Wyoming. U.G. Geol. Survey Geologic quadrangle map, GQ-887.

Metcalf, M. D. 1987. Contributions to the prehistoric chronology of the Wyoming Basin *in* A. J. Osborn and R. C. Hassler, editors. Perspectives on archaeological resources management in the Great Plains, p. 233-261. I & O Publishing Company, Omaha, Nebraska.

Metcalf, M. D. and K. Black. 1991. Archaeological excavations at the Yarmony pit house site, Eagle County, Colorado. Colorado Cultural Resource Series No. 31, Denver.

Metcalf, M. D. and P. Treat. 1979. Continuity in late prehistoric period pronghorn procurement in Southwestern Wyoming. Paper presented at the 44th Annual Meeting of the Society for American Archaeology, Vancouver, B.C.

Middleton, M. 1992. Salt content of sediments deposited along degraded and improving riparian areas; Muddy Creek Wyoming. Thesis, University of Wyoming.

Miller, M. 1997 Hollow victory: the White River Expedition of 1879 and the Battle of Milk Creek. University Press of Colorado, Niwot.

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-Frequency Atlas of the Western United States. National Oceanic and Atmospheric Administration Atlas 2, v. 2. Washington: U.S. Government Printing Office.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Pheonix, AZ.

Minckley, W. L. and J. E. Deacon. 1991. Battle against extinction: native fish management in the American West. University of Arizona Press.

Montagne, J. de la. 1991. Cenozoic history of the Saratoga Valley area, Wyoming and Colorado. University of Wyoming Contributions to Geology, V. 29, pp. 13-70.

Morris, W. J. 1954. An Eocene fauna from the Cathedral Bluffs Tongue of the Washakie Basin, Wyoming. Journal of Paleontology, v. 28, p. 195-203.

Munn, L. C. and Arneson, C. S. 1999. Soils of Wyoming: a digital statewide map at 1:500,000 scale, Agricultural Experiment Station Report B-1069 University of Wyoming, College of Agriculture, Laramie, Wyoming

Murcray, D. 1993. An assessment of the newly discovered Upper Powder Spring Sites: a hunting complex in southwest Wyoming. Wyoming Archaeologist, Vol. 37 (1-2). Springs 1993.

Murray, S. 2001. The use of domestic space in an archaic housepit: archaeological investigations at the High Point Site (48CR1790). Prepared for Williams Field Services. Submitted to the Wyoming Bureau of Land Management, Rawlins Field Office. Cultural resource management report no. 72. Western Archaeological Services, Rock Springs.

NARCS (National Applied Resource Sciences Center). 2000. Muddy Creek CRM. Bureau of Land Management, Rawlins, Wyoming.

National Earthquake Information Center (NEIC). 2003. Internet search of available earthquake database. http://neic.usgs.gov/

National Energy Policy (NEP). 2001. Report of the National Energy Policy Group, May 2001. Reliable, affordable, and environmentally sound energy for America's future. http://www.whitehouse.gov/energy/National-Energy-Policy.pdf

National Petroleum Council (NPC). 2003. Balancing natural gas policy: Fueling the demands of a growing economy. September 2003.

National Research Council. 1991. Highway deicing: Comparing salt and calcium magnesium acetate. Special report 235. Transportation Research Board, Washington, D.C.

NatureServe. 2003. NatureServe explorer: an online encyclopedia of life [web application]. Version 1.8 NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.

Nebraska Game and Parks Commission (NPPC). 2002. The blowout penstemon: an endangered species. http://www.ngp.ngpc.state.us

Nichols, J. T. 1964. Soil vegetation relationships of the 15-Mile Drainage, Washakie, County, Wyoming. Ph.D. dissertation, Univ. of Wyo.

Nowak, R. M. 1999. Walker's mammals of the world. Sixth edition. Volume 2. The Johns Hopkins University Press, Baltimore, Maryland. 1936pp.

Oakleaf, B., H. Downing, B. Raynes, M. Raynes, and O. K. Scott. 1982. Wyoming avian atlas. Wyoming Game and Fish Department and Bighorn Audubon Society. 87pp.

Oedekoven, O.O. 1985. Columbian sharp-tailed grouse population distribution and habitat use in south central Wyoming. M.S. Thesis. University of Wyoming, Laramie, WY. 58pp.

Oil and Gas Field Symposium Committee. 1957. Wyoming oil and gas fields symposium. Wyoming Geol. Assoc. 579pp.

______. 1979. Oil and gas fields C greater Green River Basin, vols. I and II. Wyoming Geol. Assoc. 428pp.

______. 1992. Oil and gas fields C greater Green River Basin, Wyoming. Wyoming Geol. Assoc. 372pp.

Pederson Planning Consultants. 1998. Carbon County land use plan. June 16, 1998.

Peterson, R.A. 1993. The erodibility of the Muddy Creek Channel. M.S. Thesis, University of Wyoming, Laramie, Wyoming.

PF Resources. 2000. Carbon/Sweetwater Counties of Wyoming: workforce report. Dallas, Texas. October.

Pipiringos, G. N. 1961. Uranium-bearing coal in the central part of the Great Divide Basin. U.S. Geol. Survey Bull., 1099-A: 104 pp.

Poland, J. F. 1984. Mechanics of land subsidence due to fluid withdrawal *in* Poland, J. F., editor. Guidebook to studies of land subsidence due to ground-water withdrawal: studies and reports in hydrology 40, prepared for the International Hydrological Programme, Working Group 8.4, United Nations Educational, Scientific, and Cultural Organization (UNESCO), Paris, France, p. 37-54.

Porter, M. A. 1999. Spatial Relationships between sympatric mule deer and elk in south-central Wyoming. M.S. Thesis. University of Wyoming, Laramie. 60pp.

Quist, M.C., M.R. Bower, and W.A. Hubert. In press. Summer food habitat and trophic overlap of round tail chub and creek chub in Muddy Creek, Wyoming. Southwestern Naturalist.

Rawlins Daily Times. 2000a. Rag Shoshone coal mine closes Thursday. August 30.

______. 2000b. Realtors believe market can handle housing needs. August 5.

______. 2001. Wamsutter ponders impacts. February 7.

Reeve, A. F. 1984. Environmental influences on male pronghorn home range and pronghorn behavior. PhD. Diss., University of Wyoming, Laramie. 172pp

Reeve, A. F., F. Lindzey, and S. Buskirk. 1986. Historic and recent distribution of the lynx in Wyoming. Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, Wyoming. 55pp.

Reiners, P. W. and Heffern, E. L. 2002. Pleistocene exhumation rates of Wyoming intermontane basins from (U-Th)/He dating of clinker, Geological Society of America Annual Meeting, Session No. 144, Rocky Mountains III: Post-Laramide Uplift and Erosion of the Rocky Mountains and Colorado Plateau Colorado Convention Center: Paper Number 144-4, presented October 29, 2002.

Renard, K. G., G. R. Foster, G. A. Weesies, D. K. McCool, and D. C. Yoder. 1997. Predicting soil erosion by water. U.S. Department of Agriculture, Agricultural Research Service, Agriculture Handbook 703.

Rice, P. M. 2002. INVADERS database system division of biological sciences, University of Montana, Missoula, MT. (http://invader.dbs.umt.edu).

Rigby, J. K., Jr. 1980. Swain Quarry of the Fort Union Formation, middle Paleocene (Torrejonian) Carbon, County, Wyoming: geological setting and mammalian fauna. Evolutionary Monographs 3, 179pp.

Ritzma, H. R. 1949. Geology along the southwest flank of the Sierra Madre, Carbon County, Wyoming. Univ. Wyoming unpub. M.A. Thesis.

Roehler, H. W. 1972. A review of Eocene Stratigraphy in the Washakie Basin, Wyoming. Wyoming Geological Association Guidebook Field Conference on Tertiary Biostratigraphy of Southern and Western Wyoming, p. 3-19.

______. 1973. Stratigraphy of the Washakie Formation in the Washakie Basin, Wyoming. U.S. Geological Survey Bulletin 1369, 40pp.

______. 1977. Geologic map of the Rock Springs uplift and adjacent areas, Sweetwater County, Wyoming. U.S. Geological Survey Open File Report 77-242, scale 1:250,000.

______. 1985. Geologic map of the Kinney Rim 30□ x 60□ minute Quadrangle, Wyoming and Colorado. U.S. Geological Survey Miscellaneous Investigation Series Map I-1615, scale 1:100,000.

______. 1991a. Revised stratigraphic nomenclature for the Wasatch and Green River Formations *in* Geology of the Eocene Wasatch, Green River, and Bridger (Washakie) Formations, Green River Basin, Wyoming, Utah, and Colorado. U.S. Geological Survey Professional Paper 1506-B, 38pp.

______. 1991b. Godiva Rim Member-a new stratigraphic unit of the Green River Formation in southwest Wyoming and northwest Colorado *in* Geology of the Eocene Wasatch, Green River, and Bridger (Washakie) Formations, Green River Basin, Wyoming, Utah, and Colorado. U.S. Geological Survey Professional Paper 1506-B, 38pp.

______. 1992a. Introduction to greater Green River Basin geology, physiography, and history of investigations. U.S. Geological Survey Professional Paper 1506-A, 14pp.

______. 1992b. Description and correlation of Eocene rocks in stratigraphic reference sections for the Green River and Washakie Basins, southwest Wyoming. U.S. Geological Survey Professional Paper 1506-D, 83pp.

______. 1992c. Correlation, composition, aerial distribution and thickness of Eocene stratigraphic units, Greater Green River Basin, Wyoming, Utah, and Colorado. U.S. Geological Survey Professional Paper 1506-E, 49pp.

______. 1993. Eocene climates, depositional environments, and geography, greater Green River Basin, Wyoming, Utah, and Colorado. U.S. Geological Survey Professional Paper 1506-F, 14pp.

Roehler, H. W., Hanley, J. H., Honey, J. G. 1988. Geology and paleoecology of the Cottonwood Creek delta in the Eocene Tipton Tongue of the Green River Formation and a mammalian fauna from the Eocene Cathedral Bluffs Tongue of the Wasatch Formation , southeast Washakie Basin, Wyoming. U.S. Geological Survey Bulletin 1669 52pp.

Rosenberg, R. 1994. IMACS site form addendum for site 48CR3648.

Rotenberry, J. T., M. A. Patten, and K. L. Preston. 1999. Brewer's Sparrow (*Spizella breweri*) *in* A. Poole and F. Gill, editors. The birds of North America, No. 390. The Birds of North America, Inc. Philadelphia, PA.

Rumbaugh, J.O., and Rumbaugh, D.B., 2002, Groundwater Vistas Version 3.33, Software and User's Manual. Environmental Simulations Inc.

Sanders, R. B. 1974. Geologic map and coal resources of the Riner Quadrangle, Carbon and Sweetwater Counties, Wyoming. U.S. Geol. Survey Coal Inv. Map, C-68.

Sanders, R. B. 1975. Geologic map and coal resources of the Creston Junction quadrangle, Carbon and Sweetwater counties, Wyoming. U.S. Geol. Surv. Coal Inv. Map: C-73.

Schlosser, I.J. 1995. Critical landscape attributes that influence fish population dynamics in headwater streams. Hydrobiologia 303:71-81.

Schroeder, T. 2005. Program Principal, Wyoming Department of Environmental Quality, Industrial Siting Division. Personal communication with Daviid Simons, USDOI BLM RFO. November 4.

Scott, A. R., Tyler, R., Hamilton, D. S., and Zhou, N. 1994. Coal and in-place gas resources of the Greater Green River Basin: American Association of Petroleum Geologists Annual Convention Program with Abstracts, v. 4, p. 253-254.

Seaber, P.R., F.P. Kapinos, and G.L. Knapp. 1987. Hydrologic unit maps. U.S. Geological Survey, Water-Supply Paper 2294.

Segerstom, T. 1982. Effects of an operational coal strip mine on pronghorn antelope. Proc. Bienn. Pronghorn Antelope Workshop. 10:174-208.

Skinner, Q.D., M.A. Smith, T.A. Wesche, and S. Lowry. 1989. A Survey of Values Associated with Riparian Conditions of a Stream Tributary to the Green/Colorado River. In Practical Approaches to Riparian Resource Management; an educational workshop, Billings, Montana. R.E. Gresswell, B.A. Barton and J.L. Kershner (editors). pp 175. *WWRC 89-48.*

Skinner, Q.D., M.A. Smith, T.A. Wesche, J.S. Todd and J.D. Rodgers. 1991. Research findings from Riparian Zone Management on Muddy Creek. In Proceedings of the third intermountain meadow symposium, Steamboat Springs, Colorado. pp. 1-8. *WWRC 91-24.*

Smith, A. M. 1974. Ethnography of the Northern Utes. Museum of New Mexico Papers in Anthropology No. 17, Albuquerque.

Smith, D. G., and J. R. Murphy. 1978. Biology of the Ferruginous Hawk in central Utah. Sociobiology 3:79-98.

Smith, J. B., Ayler, M. F., Knox, C. C., and B. C. Pollard. 1972. Strippable coal reserves of Wyoming. U.S. Bureau of Mines Inf. Circular, IC-8538: 51pp.

Smith, J. H. 1961. A summary of stratigraphy and paleontology, upper Colorado and Montanan Groups, south-central Wyoming, northeastern Utah, and northwestern Colorado; pp. 101-112 *in* Symposium on Late Cretaceous rocks, Wyoming and adjacent areas; Wyo. Geol. Assoc. 16th Ann. Field Conf. Guidebook.

Spatial Data and Visualization Center (SDVC). 2000. ARCVIEW spatial data file. University of Wyoming, Natural Resources Data Clearinghouse. http://www.sdvc.uwyo.edu.

Stebbins, R. C. 1951. Amphibians of western North America. University of California Press, Berkeley. 539pp.

Sullivan, R. 1980. A stratigraphic evaluation of the Eocene rocks of southwestern Wyoming: Geological Survey of Wyoming Report of Investigations 20, 50pp.

Suter, G. W., and J. L. Jones. 1981. Criteria for golden eagle, ferruginous hawk, and prairie falcon nest site protection. Raptor Research 15:12-18.

Swenson, J. E., K. L. Alt, and R. L. Eng. 1986. Ecology of bald eagles in the Greater Yellowstone Ecosystem. Wildlife Monographs 95:1-46.

Tart, D. L. 1996. Big sagebrush plant associations of the Pinedale Ranger District, Final Review Draft. Bridger-East Ecological Unit Inventory, Bridger-Teton National Forest.

Tart, D. L. and A. H. Winward. 1996. Revised 2001. Key to sagebrushes (*Artemesia*) of Wyoming *in* Big sagebrush plant associations of the Pinedale Ranger District, Final Review Draft. Bridger-East Ecological Unit Inventory, Bridger-Teton National Forest.

Terkla, C. 2000, 2002. Assistant Clerk, Town of Baggs. Personal communication with George Blankenship, Blankenship Consulting LLC. December 6 and January 18.

Texas Resource Consultants. 1981. Soil inventory of the Overland Area Wyoming. Prepared for the Bureau of Land Management in cooperation with the Soil Conservation Service.

Thomas, J.W., and D.E. Toweill (Eds.). 1982. Elk of North America: ecology and management. Stackpole. 698pp.

Thompson, J. 2001. Muddy Creek Coordinated Resource Management Project, Carbon County Wyoming. Workshop on Collaborative Resource Management in the Interior West, Red Lodge, Montana.

Thompson, K. W. 1989. Salvage excavations at the Nova Site, a late prehistoric housepit in south central Wyoming. Cultural Resource Management Report No. 49. Archaeological Services of Western Wyoming College, Rock Springs.

Thompson, K. W. and J. V. Pastor. 1995. People of the sage: 10,000 years of occupation in southwest Wyoming. Cultural Resource Management Report No. 67. Archaeological Services of Western Wyoming College, Rock Springs.

Trewartha, G. 1968. An Introduction to Climate. McGraw-Hill Book Coompamy, New York, NY. 408 pp.

Trombulak, S.C. and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.

Tyus, H. M., D. Burdick, R. A. Valdez, C. M. Haynes, T. A. Lytle, and C. R. Berry. 1982. Fishes of the Upper Colorado River Basin: distribution, abundance, and status. Pages 12-70 *in* W. H. Miller, H. M. Tyus, and C. A. Carlson, editors. Fishes of the Upper Colorado River system: present and future. Western Division of the American Fisheries Society. 131pp.

U.S. Census Bureau. 2002. Table DP-4. Profile of selected housing characteristics: 2000, Rawlins city, Wyoming. Online at http://eadiv.state.wy.us/demogdata/pop2000/ProfilePDFsWY/63900.pdf. June 4, 2002. Accessed August 2003.

U.S. Department of Agriculture. (USDA).1954. Agriculture Handbook 60.

U.S. Department of Agriculture Forest Service. (USDA-FS). 2000. Screening methodology for calculating ANC change to high elevation lakes, user's guide. U.S. Department of Agriculture (USDA) Forest Service, Rocky Mountain Region. January 2000.

USDA-NRCS. 1986. Precipitation zones for technical range site descriptions. U.S. Government Printing Office, Washington, DC.

U.S. Department of the Interior, Bureau of Land Management (USDI-BLM). No Date (a). Visual Resource Management (VRM) Manual H-8410, Visual Resource Inventory. Accessed online at http://www.blm.gov/nstc/VRM/8410.html, November 8, 2004.

_____. (USDI-BLM). No Date (b). Management (VRM) Manual H-8431, Visual Resource Contrast Rating. Accessed online at http://www.blm.gov/nstc/VRM/8410.html, November 8, 2004.

_____. (USDI-BLM). 1980. BLM Handbook H-8410-1 – Visual Resource Inventory. 1980.

_____. (USDI-BLM). 1987. Muddy Creek Watershed Plan, Divide Resource Area, Rawlins, Wyoming.

_____. (USDI-BLM). 1988. Proposed resource management plan/final environmental impact statement for the Great Divide Resource Area (formerly Medicine Bow and Divide Resource areas) Rawlins District, Wyoming. U.S. Department of the Interior, Bureau of Land Management, Great Divide Resource Area, Rawlins District Office, Rawlins, WY. 249pp.

_____. (USDI-BLM). 1990. Great Divide Resource Area record of decision and approved resource management plan. U.S. Department of the Interior, Bureau of Land Management, Rawlins District Office, Great Divide Resource Area, Rawlins, WY 74pp.

_____. (USDI-BLM). 1991. Final environmental impact statement (FEIS), vegetation treatment on BLM lands in the thirteen western states. Wyoming.

______. (USDI-BLM). 1994. Rawlins Field Office. Draft Environmental Impact Statement Creston/Blue Gap Natural Gas Project, Carbon and Sweetwater Counties, Wyoming. Rawlins, WY 74pp.

_____. (USDI-BLM). 1995. Environmental Impact Statement for the Greater Wamsutter Area II Natural Gas Development Project, Rawlins Field Office, WY.

_____. (USDI-BLM). 1999. Rawlins Field Office. Draft Environmental Impact Statement South Baggs Area Natural Gas Development Project, Carbon County, Wyoming. Rawlins, WY. May

_____. (USDI-BLM). 2000a. Rawlins and Rock Springs Field Offices, Record of Decision, Environmental Impact Statement, Continental Divide/Wamsutter II Natural Gas Project, Sweetwater and Carbon Counties, Wyoming, May.

_____. (USDI-BLM). 2000b. Environmental Impact Statement South Baggs Area Natural Gas Development Project, Carbon County, Wyoming. Rawlins Field Office. August, 2000.

_____. (USDI-BLM). 2001a. Instruction Memorandum No. WY-2001-040, from Alan R. Pierson, State Director, Cheyenne, WY. April 9, 2001. Issuance of BLM (Wyoming) Sensitive Species Policy and List.

_____. (USDI-BLM). 2001b. Environmental Assessment for the Atlantic Rim Coalbed Methane Project, Sun Dog Pod, Carbon County, Wyoming, Rawlins Field Office. September, 2001

_____. (USDI-BLM). 2002a. BLM Wyoming sensitive species policy and list, September 20, 2002. Bureau of Land Management, Cheyenne, Wyoming. 14pp.

_____. (USDI-BLM). 2002b. Environmental Assessment for the Atlantic Rim Coalbed Methane Project, Blue Sky Pod, Carbon County, Wyoming, Rawlins Field Office. January, 2002.

_____. (USDI-BLM). 2002c. Environmental Assessment for the Atlantic Rim Coalbed Methane Project, Cow Creek Pod, Carbon County, Wyoming, Rawlins, WY. February 2002.

_____. (USDI-BLM). 2003a. FEIS and ROD for Powder River Basin Oil and Gas Project (BLM/WY/PL-03/004+1310). January 2003, 20pp.

_____. (USDI-BLM). 2003b. Rawlins Field Office, Rawlins resource management plan management situation analysis (MSA), online at http://www.rawlinsrmp.com/documents_MSA.html, accessed October 2003.

_____. (USDI-BLM). 2003c. Wild horse herd management areas. Rawlins Field Office, Bureau of Land Management Wyoming. (http://www.blm.gov/rfo/wh.htm)

_____. (USDI-BLM). 2003d. Environmental Assessment for the Atlantic Rim Coalbed Methane Project, Brown Cow POD, Carbon County, Wyoming, Rawlins Field Office. December, 2003.

_____. (USDI-BLM). 2003e. Environmental Assessment for the Atlantic Rim Interim Drilling Project, Doty Mountain POD, Carbon County, Wyoming, Rawlins Field Office. October, 2003.

_____. (USDI-BLM). 2003f. Environmental Assessment for the Atlantic Rim Interim Drilling Project, Red Rim POD, Carbon County, Wyoming, Rawlins Field Office. November, 2003.

_____. (USDI-BLM). 2003g. Environmental Impact Statement for the Desolation Flats Natural Gas Development Project, Sweetwater and Carbon Counties, Wyoming, Rawlins and Rock Springs Field Offices.

_____. (USDI-BLM). 2004a. Draft Environmental Impact Statement for The Rawlins Resource Management Plan (2 Vol.). Rawlins Field Office (RFO), Rawlins, Wyoming.

_____. (USDI-BLM). 2004b. Environmental Assessment for the Atlantic Rim Interim Drilling Project, Jolly Roger POD, Carbon County, Wyoming, Rawlins Field Office. September, 2004.

_____. (USDI-BLM) and Hayden-Wing Associates. 2004. Biological assessment of threatened, endangered, and proposed species for the Atlantic Rim Coalbed Methane Development Project. Rawlins Field Office, Rawlins, WY.

U.S. Department of the Interior, Fish and Wildlife Service. (USDI-FWS). 1985. Recovery plan for the Pahranagat roundtail chub, *Gila robusta jordani*. U.S. Fish and Wildlife Service, Portland, Oregon. 71pp.

_____. (USDI-FWS). 1989. Black-footed ferret survey guidelines for compliance with the Endangered Species Act. U.S. Department of the Interior, Fish and Wildlife Service, Denver, CO and Albuquerque, NM. 15pp.

_____. (USDI-FWS). 1993. Colorado River endangered fishes critical habitat. Draft biological support document. Salt Lake City, Utah.

_____. (USDI-FWS). 2002. Endangered, threatened, proposed, petitioned and candidate species of Wyoming. Wyoming Field Office, Cheyenne, WY.

_____. (USDI-FWS). 2004a. Threatened, endangered, and proposed species of Carbon, County, Wyoming. Fish and Wildlife Service, Cheyenne, Wyoming.

U.S. Department of Labor, Bureau of Labor Statistics. (USDL-BLS). 2000. Incidence rates of nonfatal occupational injuries and illnesses by selected industries and case types. Washington, D.C.

U. S. Department of Transportation. (USDOT). 1998. Hazardous liquid and natural gas pipeline safety data and property damage. National Transportation Statistics. Washington, D.C.

U.S. Geological Survey (USGS). 1976. Hydrologic unit map, 1974, State of Wyoming. U.S. Geological Survey, Reston, Virginia.

_____. 1980. Water resources data for Wyoming, water year 1978: v. 2 USGS Water-Data Report WY-78-2.

_____. 2005. Streamflow and surface water quality summaries of USGS stations available on the Internet. http://waterdata.usgs.gov/usa/nwis/.

Upper Colorado River Endangered Fish Recovery Program. 1999. Website of the Upper Colorado River Endangered Fish Recovery Program. http://www.r6.fws.gov/coloradoriver.

Utah Department of Natural Resources. 2004. Range-wide Conservation Agreement for Roundtail Chub, Gila robusta, Bluehead Sucker, Catostomus discobolus, and Flannelmouth Sucker, Catostomus latipinnis. Utah Department of Natural Resources, Salt Lake City, Utah.

Valdez, R. A. and G. H. Clemmer. 1982. Life history and prospects for recovery of the humpback and bonytail chub. Pages 109-119 *in* Miller, W.H., H.M. Tyus, and C.A. Carlson, editors. Fishes of the upper Colorado River system: present and future, Bethesda, MD: Western Division, American Fisheries Society.

Valdez, R. A., R. J. Ryel, S. W. Carothers, and D. A. House. 2000. Recovery goals for the humpback chub (*Gila cypha*) of the Colorado River Basin: A supplement to the humpback chub recovery plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

Van Voast, W. A.. 2003. Geochemical signature of formation waters associated with coalbed methane. AAPG Bulletin, Vol. 87, No. 4. pp 667-676.

Vosika, B. N. 2000. USDI-BLM NEPA Coordinator, Rawlins Field Office. Personal communication with George Blankenship, Blankenship Consulting LLC. May 5.

Waldner, V. 2000. Personal communication with George Blankenship, Blankenship Consulting LLC. December 5.

_____. 2002. Personal communication with George Blankenship, Blankenship Consulting LLC. January 18.

Warren, A. 2000. USDI-BLM Range Management Specialist, Rawlins field Office. Personal communication with George Blankenship, Blankenship Consulting LLC. June 14.

_____. 2002. Range Management Specialist, Rawlins BLM Field Office. Personal communication with Larry E. Bennett, Hayden-Wing Associates, February 11.

Waters, T.F. 1995. Sediment in Streams: Sources, Biological Effects and Control. Monograph 7. American Fisheries Society, Bethesda, Maryland.

Weigel, J. F. 1987. Sources of hydrologic data on Mesozoic formations in the Upper Colorado River Basin and comparison of data analysis methods, p. 71-80 *in* J. S. McLean and A. I. Johnson, editors. Regional aquifer systems of the United States: aquifers of the western mountain area. Amer. Water Res. Assoc. Mono. Ser. No. 14. 23rd Annual AWRA Conference and Symposium, No. 1-6, 1987, Salt Lake City, UT. 229pp.

Weishampel, D. B. 1992. Dinosaurian distribution *in* Weishampel, D. B., Dodson, P., and Osmolska, H., editors. The Dinosauria, University of California Press, Berkeley, p.63-139.

Weiss, S. J., E. O. Otis, and O. E. Maughan. 1998. Spawning ecology of flannelmouth sucker, *Catostomus latipinnis* (Catostomidae), in two small tributaries of the lower Colorado River. Environmental Biology of Fishes. 52:419-433.

Weitz, J. L., and J. D. Love. 1952. Geologic map of Carbon County, Wyoming. U.S. Geol. Survey and Wyoming Geol. Survey Map. Scale 1:160,000.

Welder, G. E. and L. J. McGreevy. 1966. Groundwater reconnaissance of the Great Divide and Washakie Basins and some adjacent areas, Southwestern Wyoming. U.S. Geological Survey, Hydrologic Investigations Atlas, HA-219.

Wells, R. W., T. K. Dioney, E. G. Knox, and R.W. Pols. 1981. Soil inventory of the Overland Area, Wyoming (2 vol.). Prepared for the Bureau of Land Management in cooperation with the Soil Conservation Service. Soil and Land Use Tech., Inc., Columbia, MD

Western Regional Climate Center. (WRCC). 2005. Climate summary for stations 487533 (Rawlins), 480484 (Baggs), 482610 (Dixon), and 489459 (Wamsutter). Available on the internet: http://www.wrcc.dir.edu.

Wiens, J. A. and M. I. Dyer. 1975. Rangeland avifaunas: their composition, energetics, and role in the ecosystem. p. 145-181 *in* D. R. Smith, technical coordinator. Symposium on management of forest and range habitat for non-game birds. U.S. Forest Service General Technical Report WO-1.

Williams, V. 2001. Maintenance Department, Town of Wamsutter. Personal communication with George Blankenship, Blankenship Consulting LLC, April 16.

Willis, J. 2000. Country Inn Motel, Baggs, WY. Personal communication with George Blankenship, Blankenship Consulting LLC. June 7.

Winterfeld, G. F. 1982. Mammalian paleontology of the Fort Union Formation (Paleocene), eastern Rock Springs Uplift, Sweetwater County, Wyoming. Contributions to geology. The University of Wyoming. v. 21 , p 73-111.

Winward, A. H. 1988. Discussions on *Artemesia in* H. J. Fisser, editor. Proc. of the 17th Wyoming shrub ecology workshop. Dept. of Range Manage., Univ. of Wyo., Laramie.

______. 1993. Unpublished field trip notes by WGFD Region 4 Habitat personnel, Star Valley, 2 September 1993.

Wischmeier, W. H., and D. D. Smith. 1978. Predicting rainfall erosion losses. U.S. Department of Agriculture, Agricultural Research Service, Agriculture Handbook 537.

Wollmer, S. 1994. Effects of Multiple Use on Rainsplash Erosion and Runoff in Semiarid Rangeland. Thesis for Masters of Arts in Geography, San Francisco State University, California.

Woolley, T. P., F. G. Lindzey, and R.Rothwell. 1995. Swift fox surveys in Wyoming: annual report. Wyoming Cooperative Fish and Wildlife Research Unit and Wyoming Game and Fish Department. Cheyenne, WY. 20pp.

WWC Engineering (WWC), 2005, Technical Report for the Atlantic Rim Natural Gas Project, Groundwater Modeling of Impacts Associated with Coal Bed Natural Gas Development. Prepared in support of the Atlantic Rim Natural Gas Project EIS, USDI-BLM, Rawlins Field Office.

Wyoming Department of Administration and Information. (WDAI). 2001. Division of economic analysis. Population for counties and incorporated places: 1990 and 2000.

______. (WDAI). 2002a. Wyoming and county population estimates and components of changes: 2000 to 2002. Online at http://eadiv.state.wy.us/pop/CO-02EST.htm. Accessed October 2003.

______. (WDAI). 2002b. Wyoming incorporated place population estimates: April 1, 2000 to July 1, 2002. Online at http://eadiv.state.wy.us/pop/SUB-02EST.htm. Accessed October 2003.

______. (WDAI). 2003a. Employment by industry for the United States, Wyoming and Wyoming counties.

______. (WDAI). 2003b. Regional economic profiles. Webpage. http://eadiv.state.wy.us/i&e/econ-profile.htm

______. (WDAI). 2003c. Total tax collections by county. Website: http://eadiv.state.wy.us/s&UTax/s&u.asp.

______. (WDAI). 2003d. Consensus revenue estimating group, Wyoming state revenue forecasts. Fiscal Year 2003 - Fiscal Year 2008. Table 6. Mineral severance taxes to all accounts; fiscal year distributions by mineral. January.

Wyoming Department of Employment. 2001. Wyoming labor market information. Local area unemployment statistics: 1995 - 2000. http://lmi.state.wy.us/laus/toc.htm.

______. 2004. Local area labor force information. 1990-2003 Wyoming Benchmark Labor Force Estimates--annual Averages. Website: http://doe.state.wy.us/lmi/laus/9002aa.htm

Wyoming Department of Environmental Quality (WDEQ). 2003. Wyoming's long term strategy for visibility protection 2003 review report – Appendix E, Visibility monitoring data assessment. Wyoming Department of Environmental Quality, Air Quality Division. May 29, 2003.

_____. 2004. Wyoming's 2004 305(b) State Water Quality Assessment Report and 2004 303(d) List of Waters Requiring TMDLs, June 2004.

_____. 2005. Water Quality Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards, June 21, 2001. Available on the Internet: <http://deq.state.wy.us/wqd/surfacestandards/>.

Wyoming Department of Revenue (WDOR). 2003. Excise Tax Division. Sales, use and lodging tax rates effective 10/1/2003. Web page: HTTP://revenue.state.wy.us/contentroot/MapsPubs/salestax/MASTER Rates 10-1-03.pdf

REFERENCES CITED

Wyoming Department of Transportation. (WYDOT). 2000, 2002. Highway safety program vehicle crash data. August 22, January 10.

_____. (WYDOT). 2001. Transportation planning program. Vehicle miles 2001.

Wyoming Game and Fish Department. (WGFD). 1991. Wyoming trout stream classification map. Wyoming Game and Fish Department, Biological Services Section, Cheyenne, WY. 1pp.

_____. (WGFD). 1996. Herd unit land statistics. Wyoming Game and Fish Department, Biological Services Section, Cheyenne, WY.

_____. (WGFD). 1998. Muddy Creek Basin management plan. Wyoming Game and Fish Department, Cheyenne, WY.

_____. (WGFD). 1999. Atlas of birds, mammals, reptiles and amphibians in Wyoming. Wyoming Game and Fish Department, Biological Services Section, Lander, WY. 190pp.

_____. (WGFD). 2003a. Wildlife Observation System (WOS) database printout. T12-21N: R88-92W. Wyoming Game and Fish Department, Cheyenne, WY. November 17, 2003.

_____. (WGFD). 2003b. Annual big game herd unit reports 2002. Wyoming Game and Fish Department, Green River Region, Cheyenne, WY. 349pp.

_____. (WGFD). 2003c. Annual report of upland game and furbearer harvest 2002. Wyoming Game and Fish Department, Cheyenne, WY.

_____. (WGFD). 2004a. Streams and lakes inventory database. Available on the Internet: http://deq.state.wy.us/wqd/surfacestandards. August 20, 2004.

_____. (WGFD). 2004b. Warmwater stream assessment manual. Wyoming Game and Fish Department, Cheyenne, WY.

_____. (WGFD). 2004c. Minimum programmatic standards recommended by the Wyoming Game and Fish Department to sustain wildlife habitats affected by oil and gas development. Wyoming Game and Fish Department, Cheyenne, WY

Wyoming Geological Survey. (WGS). 2003. 100 years of earthquakes (1871-1970). www.wsgsweb.uwyo.edu/coop.asp, www.wrds.uwyo.edu/wrds/wsgs/hazards/quakes/quake.html

Wyoming Housing Database Partnership. (WHDP). 2001. Carbon County profile. June 4, 2001.

Wyoming Natural Diversity Database. (WYNDD). 2003. Data compilation for T. Olson, for the Atlantic Rim Project Area, completed August 21, 2003. Unpublished report. Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming.

Wyoming Oil and Gas Conservation Commission (WOGCC). 1995 - 2000. 1995 - 1998. Annual Statistical Summaries 1995 through 2000. Casper, WY.

Wyoming Taxpayers Association. (WTA). 2002. Wyoming property taxation 2002. Cheyenne, WY. December.

Wyoming Water Resources Data System (WRDS). 2002. Surface water quality analyses at selected sampling stations. Available on the Internet: <http://www.wrds.uwyo.edu>.

______ 2004. Streamflow measurements at selected gaging stations. Available on the Internet: <http://www.wrds.uwyo.edu>.

GLOSSARY

abandon: To cease producing oil or gas from a well when it becomes unprofitable. An exploration well may be abandoned after it has been proven nonproductive. Usually, some of the casing is removed and salvaged, and one or more cement plugs placed in the borehole to prevent migration of fluids between formations.

acre foot: A volume of water that covers an area of one acre to a depth of one foot (43,560 cubic feet or 325,851 gallons).

ad valorem: Levied according to assessed value.

affected environment: The biological, physical, and socioeconomic environment that will or may be changed by actions proposed and the relationship of people to that environment.

allotment: An area of land where one or more permittees graze their livestock. Generally consists of public land but may include parcels of private or State lands. The number of livestock and season of use are stipulated for each allotment. An allotment may consist of several pastures or be only one pasture.

alluvium: General term for debris deposited by streams on river beds, floodplains, and alluvial fans, especially deposits brought down during a flood. Applies to stream deposits of recent time. Does not include below water sediments of seas and lakes.

alternative: A combination of management prescriptions applied in specific amounts and locations to achieve a desired management emphasis or expressed in goals and objectives. One of several policies, plans, or projects proposed for decision making.

ambient: The environment as it exists at the point of measurement and against which changes or impacts are measured.

ambient air quality: The state of the atmosphere at ground-level as defined by the range of measured and/or predicted ambient concentrations of all significant pollutants for all averaging periods of interest.

ambient concentration: The mass of a pollutant in a given volume of air. It is typically measured as micrograms of pollutant per cubic meter of air.

ambient standards: The absolute maximum level of a pollutant allowed to protect either public health (primary) or welfare (secondary).

animal unit month (AUM): The amount of forage necessary for the sustenance of one cow/calf pair for 1 month.

anticline: An arched, inverted-trough configuration of folded and stratified rock layers.

Application for Permit to Drill (APD): The Department of Interior application permit form to authorize oil and gas drilling activities on federal land.

aquifer: A water-bearing bed or layer of permeable rock, sand, or gravel capable of yielding water, or the part of a water-driven reservoir that contains the aquifer.

Area of Critical Environmental Concern: An area that needs special management attention to preserve historic, cultural, or scenic values; to protect fish and wildlife resources or other natural systems or processes; or to protect life and provide safety from natural hazards.

artesian: Groundwater with sufficient pressure to flow without pumping.

assemblage: A group of rocks grouped together by age or similar origin.

background concentration: The existing levels of air pollutant concentration in a given region. In general, it includes natural and existing emission sources, but not future emission sources.

badland: Steep or very steep, commonly non-stony barren land dissected by many intermittent drainage channels. Badland is most common in semi-arid and arid regions where streams are entrenched in soft geologic material. Runoff potential is very high, and geologic erosion is active in such areas.

basin: A closed geologic structure in which the beds dip toward the center; the youngest rocks are at the center of a basin and are partly or completely ringed by progressively older rocks.

Best Available Control Technology (BACT): The best available air pollution control technology for a given emission source, considering environmental benefits, economic and energy costs, as defined by the applicable air quality regulatory authority.

big game: Those species of large mammals normally managed as a sport hunting resource.

borehole: A circular hole made by boring; especially a deep hole of small diameter, such as an oil well or a water well.

Bureau of Land Management (BLM): The Department of Interior agency responsible for managing most Federal Government subsurface minerals. It has surface management responsibility for Federal lands designated under the Federal Land Policy and Management Act of 1976.

canopy: The more-or-less continuous cover of branches and foliage formed collectively by the crown of adjacent trees and other woody growth.

carrying capacity: The ability of an area of land to sustain a species [generally livestock] over time without permanently degrading the land resources.

casing: Steel pipe placed in an oil or gas well to prevent the hole from collapsing.

completion: The activities and methods to prepare a well for production. Includes installation of equipment for production from an oil or gas well.

Condition of Approval (COA): Conditions or provisions (requirements) under which an Application for a Permit to Drill or a Sundry Notice is approved.

coniferous: Referring to a cone-bearing, usually evergreen, tree.

contrast: The effect of a striking difference in the form, line, color, or texture of the landscape features within the area being viewed.

Controlled Surface Use (CSU): Use or occupancy is allowed (unless restricted by another stipulation), but identified resource values require special operational constraints that may modify the lease rights. CSU is used for operating guidance, not as a substitute for the NSO or Timing stipulations.

corridor: A strip of land, usually a few to many times the width of a right-of-way through which one or more facilities (e.g. pipelines, roads, powerlines) may be located.

Council on Environmental Quality (CEQ): An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews Federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

criteria pollutants: Air pollutants for which the EPA has established State and National Ambient Air Quality Standards. These include particulate matter (PM_{10}), nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), and volatile organic compounds (VOC).

crucial range: Any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain itself at a certain level over the long-term.

cubic feet per second (cfs): The rate of discharge representing a volume of 1 cubic foot of water passing a given point during 1 second.

cubic foot: The volume of gas contained in one cubic foot of space at a standard pressure base of 14.7 psi and a standard temperature base of 60 degrees Fahrenheit.

cultural resources: The physical remains of human activity (artifacts, ruins, burial mounds, petroglyphs, etc.) and the conceptual content or context (as a setting for legendary, historic, or prehistoric events, such as a sacred area of native peoples, etc.) of an area of prehistoric or historic occupation.

cumulative impact: The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taken place over a period of time (40 CFR 1508.7).

deciduous: Trees or shrubs that lose their leaves each year during a cold or dry season.

decibel: A unit of measurement of noise intensity. The measurements are based on the energy of the sound waves and units are logarithmic. Changes of 5 decibels or more are normally discernible to the human ear.

development well: A well drilled in proven territory (usually within 1 mile of an existing well).

directional drilling: The intentional deviation of a wellbore from vertical to reach subsurface areas off to one side from the drilling site.

discharge: The volume of water flowing past a point per unit time, commonly expressed as cubic feet per second (cfs), gallons per minute (gpm), or million gallons per day (mgd).

dispersion: The spreading out of pollutants. Generally, used to show how much an air pollutant will spread from a particular point.

displacement: As applied to wildlife, forced shifts in the patterns of wildlife use, either in location or timing of use.

disposal well: A well into which produced water from other wells is injected into an underground formation for disposal.

dissolved solids: The total amount of dissolved material, organic and inorganic, contained in water or wastes.

disturbance: An event that changes the local environment by removing organisms or opening up an area, facilitating colonization by new, often different, organisms.

disturbed area: Area where natural vegetation and soils have been removed or disrupted.

diversity: The distribution and abundance of different plant and animal communities and species within the area covered by a Land and Resource Management Plan.

drainage: Natural channel through which water flows some time of the year. Natural and artificial means for effecting discharge of water as by a system of surface and subsurface passages.

drill bit: The cutting devise used to drill a well. It is typically made of hardened steel, and may have industrial grade diamond components.

drilling mud: The circulating fluid used to bring cuttings out of the well bore, cool the drill bit, and provide hole stability and pressure control. Drilling mud includes a number of additives to maintain the mud at desired viscosities and weights. Some additives that may be used are caustic, toxic, or acidic.

drill pad: Relatively flat work area that contains equipment and facilities used for well drilling and well completion.

drill pipe: The heavy seamless tubing used to rotate the drill bit and circulate the drilling fluid. The standard drill pipe section is 30 feet long (a joint).

drill rig: The mast, draw works, and attendant surface equipment of a drilling workover unit.

dry hole: Any well incapable of producing oil or gas in commercial quantities. A dry hole may produce water, gas or even oil, but not enough to justify production.

earthquake: Sudden movement of the earth's crust resulting from faulting, volcanism, or other mechanisms.

ecosystem: An interacting system of organisms considered together with their environment for example, marsh, watershed, and stream ecosystems.

effects: These include: a) Direct effects, which are caused by the action and occur at the same time and place; b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative.

> Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (40 CFR 1508.8).

emergent vegetation: Erect, rooted, herbaceous plants that project out of the water, or "emerge."

emission factor: An empirically derived mathematical relationship between pollutant emission rate and some characteristic of the source such as volume, area, mass, or process output.

endangered species (animal): Any animal species in danger of extinction throughout all or a significant portion of its range. This definition excludes species of insects that the Secretary of the Interior determines to be pests and whose protection under the Endangered Species Act of 1973 would present an overwhelming and overriding risk to man.

endangered species (plant): Species of plants in danger of extinction throughout all or a significant portion of their ranges. Existence may be endangered because of the destruction, drastic change, or severe curtailment of habitat, or because of over exploitation, disease, predation, or even unknown reasons. Plant taxa from very limited areas (e.g. the type localities only), or from restricted fragile habitats usually are considered endangered.

endemic: Confined naturally to a particular geographic area. Often used in opposition to the work epidemic.

environment: The aggregate of physical, biological, economic, and social factors affecting organisms in an area.

environmental assessment (EA): An investigation of a proposed action and alternatives to that action and their direct, indirect, and cumulative environmental impacts; the process which provides the necessary information for reaching an informed decision and the information needed for determining whether a proposed action may have significant environmental effects and determining the type of environmental documents required.

environmental impact statement (EIS): An analysis of alternative actions and their predictable environmental effects, including physical, biological, economic, and social consequences and their interactions; short- and long-term effects; direct, indirect, and cumulative effects.

ephemeral drainage: A drainage area or a stream that has no base flow. Water flows for a short time each year but only in direct response to rainfall or snowmelt events.

ephemeral stream: A stream that flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice and which has a channel bottom that is always above the local water table.

emission: Air pollution discharge into the atmosphere, usually specified by mass per unit time.

erosion: The removal, detachment, and entrainment of earth materials by weathering, dissolution, abrasion, and corrosion, later to be transported by moving water, wind, gravity, or glaciers.

exploration: The search for economic deposits of minerals, ore, and other materials through practices of geology, geochemistry, geophysics, drilling, and/or mapping.

exploration well: A well drilled in an area where there is no oil or gas production. (Check ch.1 to see if added)

fault: A fracture in bedrock along which there has been vertical and/or horizontal movement caused by differential forces in the earth's crust.

federal lands: All lands and interests in lands owned by the U.S. that are subject to the mineral leasing laws, including mineral resources or mineral estates reserved to the U.S. in the conveyance of a surface or non-mineral estate.

fisheries: Streams and lakes used for fishing.

floodplain: That portion of a river valley, adjacent to the channel, which is built of recently deposited sediments and is covered with water when the river overflows its banks at flood stages.

fluvial: Comprehensive term for river processes.

footprint: The actual surface area physically disturbed by oil and gas operations and ancillary facilities.

forage: Vegetation of all forms available for animal consumption.

forb: A broad-leafed flowering herb other than grass.

formation (Geologic): A rocky body distinguishable from other rock bodies and useful for mapping or description. Formations may be combined into groups or subdivided into members.

fugitive dust: Airborne particles emitted from any source other then through a controllable stack or vent.

functional value: A term that refers to the various functions performed by wetlands and the values people place on those functions. Functions are the chemical, physical, and biological processes or attributes of a wetland without regard to their importance to society. They include groundwater recharge and discharge, sediment trapping, nutrient/pollutant retention and removal, shoreline anchoring and dissipation of erosive forces, food chain support, wildlife and fish habitat, and heritage value (including active and passive recreation, uniqueness, etc.).

game species: Animals commonly hunted for food or sport.

grade: A slope stated in terms of feet per mile or as feet per feet (percent); the content of precious metal per volume of rock (ounces per ton).

groundwater: Water contained in the pore spaces of consolidated and unconsolidated surface material.

habitat: A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

habitat type: The aggregate of all areas that support or can support the same primary vegetation at climax.

hazardous waste: (A) Any substitute designated pursuant to section 311(b)(2)(A) of the Federal Water Pollution Control Act. (B) Any element, compound, mixture, solution, or substance designated pursuant to section 102 of this Act. (C) Any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act (but not including any waster the regulation of which under the Solid Waste Disposal Act has been suspended by Act of Congress). (D) Any toxic pollutant listed under section 307(a) of the Federal Water Pollution Control Act. (E) Any hazardous air pollutant listed under section 112 of the Clean Air Act. (F) Any imminently hazardous chemical substance or mixture with respect to which the Administrator has taken action pursuant to section 7 of the Toxic Substances Control Act. The term does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).

herbaceous: The plant strata which contain soft, not woody, stemmed plants that die to the ground in winter.

hydric soils: A soil that is saturated, flooded, or ponded with water long enough during the growing season (i.e., soil temperature of 41°F at 20 inches depth) to develop anaerobic soil conditions (i.e., reduced oxygen levels). These soils develop characteristics that are indicative of the wet and anaerobic conditions. Such characteristics may include an undecomposed organic surface layer (histic epipedon), surface horizons with low chromas (i.e., very dark brown to black), organic staining and streaking, grey-colored layers of horizons, iron concretions, and/or light grey- or rust-colored mottles or specks of highly contrasting color. These characteristics must generally occur within 50 percent of the root zone.

hydrology: A science that deals with the properties, distribution, and circulation of surface and subsurface water.

hydrophytic plants: Those species which either require or tolerate wet or saturated soils and are therefore indicative of these conditions. Vegetation is a good indicator of the physical conditions on a given site. Such conditions include soil moisture.

hydrostatic testing: Testing of the integrity of a newly placed, but uncovered pipeline for leaks. The pipeline is filled with water and pressurized to operating pressures, and the pipeline is visually inspected.

impact: The results of an action on the environment; the impact may be primary (direct) or secondary (indirect); the term impact is synonymous with effect according to 40 CFR 1508.8.

infiltration: The movement of water or some other liquid into the soil or rock through pores or other openings.

infrastructure: The basic framework or underlying foundation of a community including road networks, electric and gas distribution, water and sanitation services, and facilities.

injection well: A well used to inject fluids into an underground formation to increase reservoir pressure.

interdisciplinary team (IDT): A group selected to work within the NEPA process in scoping, analysis, and document preparation. The purpose of the team is to integrate its collective knowledge of the physical, biological, economic, and social sciences and the environmental design arts into the environmental analysis process. Interaction among team members often provides insight that otherwise would not be apparent.

intermittent stream: A stream or reach of a stream that drains a watershed of at least one square mile; or a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and groundwater discharge.

jurisdictional wetlands: "Those wetlands which are within the extent of COE regulatory overview" (33 CFR 328.1 and (2). For an area to be identified as a jurisdictional wetland, the area must exhibit positive indicators of wetland hydrology, hydrophytic vegetation, and hydric soils. Those areas that do not meet the three parameters are uplands or non-jurisdictional wetlands. The Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) describes technical criteria for determining hydrophytic vegetation, hydric soils, and wetland hydrology, and therefore the occurrence of jurisdictional wetlands.

landform: Any physical, recognizable form or feature of the Earth's surface, having a characteristic shape and produced by natural causes. Includes major features such as plains, plateaus, and mountains, and minor features, such as hills, valleys, slopes, canyons, arroyos, and alluvial fans.

landscape character: The arrangement of a particular landscape as formed by the variety and intensity of the landscape features as defined as the four basic elements (form, line, color, and texture). These factors give the area a quality that distinguishes it from its immediate surroundings.

landslide: A perceptible downhill sliding or falling of a mass of soil and rock lubricated by moisture or snow.

land use: Land uses determined for a given area that establish the types of activities allowed (e.g., mining, agriculture, timber production, residential, industrial).

lead agency: The agency or agencies preparing or having taken primary responsibility for preparing the environmental impact statement (40 CFR 1508.16).

lease: (1) A legal document that conveys to an operator the right to drill for oil and gas. (2) The tract of land on which a lease has been obtained, where producing wells and production equipment are located.

leasable minerals: Federal minerals subject to lease under the Mineral Leasing Act of 1920, as amended, and supplemented. Includes minerals, such as oil, gas, coal, geothermal, tar sands, oil shale, potassium, phosphate, sodium, asphaltic materials.

lek: An assembly area for communal courtship display, usually in reference to greater sage-grouse or other grouse.

lithic scatter: A surface scatter of cultural artifacts and debris that consists entirely of lithic (i.e., stone) tools and chipped stone debris. This is a common prehistoric site type that is contrasted to a cultural material scatter, which contains other or additional artifact types such as pottery or bone artifacts, to a camp which contains habitation features, such as hearths, storage features or occupation features, or to other site types that contain different artifacts or features.

loam: A mixture of sand, silt, and clay containing between 7 and 27 percent clay, 28 to 50 percent silt and less than 50 percent sand.

management area: An area composed of aggregate pieces of land (generally several to many analysis areas) to which a given management objective and prescriptions are applied.

management direction: A statement of multiple use and other goals and objectives, along with the associated management prescriptions and standards and guidelines to direct resource management.

mesic area: A habitat having a moderate amount of moisture available for the support of plant life.

methane (CH_4): The simplest hydrocarbon; natural gas is nearly pure methane.

mineral rights: Reserved mineral rights are the retention of ownership of all or part of the mineral rights by a person or party conveying land to the United States. Conditions for exercising these rights have been defined in the Secretary's "Rules and Regulations to Govern Exercising of Mineral Rights Reserved in Conveyances to the United States" attached to and made a part of deeds reserving mineral rights.

mitigate: To lessen the severity.

mitigation: Avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree of magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and/or compensating for the impact by replacing or providing substitute resources or environments.

modeling: A mathematical or physical representation of an observable situation. In air pollution control, models afford the ability to predict pollutant distribution or dispersion from identified sources for specified weather conditions.

monitor: To systematically and repeatedly watch, observe, or measure environmental conditions in order to track changes.

National Ambient Air Quality Standards (NAAQS): The allowable concentrations of air pollutants in the air specified by the Federal government. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants).

National Environmental Policy Act (NEPA): The federal law established in 1969, which went into effect on January 1, 1970, that (1) established a national policy for the environment, (2) requires federal agencies to become aware of the environmental ramifications of their proposed actions, (3) requires full disclosure to the public of proposed federal actions and a mechanism for pubic input into the federal decision-making process, and (4) requires federal agencies to prepare an environmental impact statement for every major action that would significantly affect the quality of the human environment.

National Register of Historic Places: A list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture.

native species: Plants that originated in the area in which they are found, i.e., they naturally occur in that area.

natural gas: Those hydrocarbons, other than oil and other than natural gas liquids separated from natural gas, that occur naturally in the gaseous phase in the reservoir and are produced and recovered at the wellhead in gaseous from. Natural gas includes coal bed methane gas.

No Action Alternative: The management direction, activities, outputs, and effects that are likely to exist in the future if the current plan would continue unchanged.

Notice of Staking: Prior to filing a complete Application for Permit to Drill (APD) an Operator may wish to file a Notice of Staking (NOS). Under this procedure, the site is surveyed and staked, and the onsite inspection is used to provide information to the Operator prior to the Operator committing time and money in preparing an APD which might not reflect agency concerns.

noxious weeds: Officially designated undesirable or invading weedy species generally introduced into an area due to human activity.

ozone: A molecule containing three oxygen atoms (O_3) produced by passage of an electrical spark through air or oxygen (O_2).

paleontology: The science that deals with the history and evolution of life on earth.

parent materials: Unconsolidated material formed from bedrock which undergoes further changes to form soil.

particulate matter: A particle of soil or liquid matter (e.g., soot, dust, aerosols, fumes and mist).

perennial stream: A stream or reach of a stream that flows throughout the year.

permeability: Extent that a substance is open to passage or penetration, especially by fluids.

permittee (grazing): A person who has livestock grazing privileges on an allotment or allotments within the resource area.

pH: The negative $\log_{10}$ of the hydrogen ion activity in solution; a measure of acidity or basicity of a solution.

playa: The shallow central basin of a desert plain, in which water gathers after a rain and is evaporated.

preferred alternative: The alternative identified in the EIS as the action favored by the agency.

prevailing wind: The most frequent compass direction from which the wind blows.

prevention of significant deterioration of air quality (PSD): A classification established to preserve, protect, and enhance the air quality in National Wilderness Preservation System areas in existence prior to August 1977 and other areas of National significance, while ensuring economic growth can occur in a manner consistent with the preservation of existing clean air resources. Specific emission limitations and other measures, by class, are detailed in the Clean Air Act (42 U.S.C. 1875 et 15q.).

produced water: Formation water pumped during the development of a gas well.

PSD increments: The maximum allowable increase in pollutant concentrations permitted over baseline conditions as specified in the EPA Prevention of Significant Deterioration (PSD) regulations (40 CFR Part 52.21). The regulations apply only to area currently attaining NAAQS/WAAQS. Most National Parks and Wilderness areas are Class I Areas, where almost no future pollution increase is permitted. Most other areas are Class II Areas, where moderate increases in pollution levels are allowed.

public land: Lands or interests in lands owned by the United States and administered by the Secretary of Interior through the Bureau of Land Management, without regard to how the United States acquired ownership.

range: Land producing native forage for animal consumption and lands that are revegetated naturally or artificially to provide forage cover that is managed like native vegetation, which are amenable to certain range management principles or practices.

raptor: Living on prey; a group of carnivorous birds consisting of hawks, eagles, falcons, kites, vultures, and owls.

reclamation: rehabilitation of a disturbed area to make it acceptable for designated uses. This normally involves regrading, replacement of topsoil, revegetation and other work necessary to restore it for use.

record of decision (ROD): A decision document for an Environmental Impact Statement or Supplemental EIS that publicly and officially discloses the responsible official's decision regarding the actions proposed in the EIS and their implementation.

reserve pit: (1) Usually an excavated pit that may be lined with plastic, that holds drill cuttings and waste mud. (2) Term for the pit which holds the drilling mud.

reserves: Identified resources of mineral-bearing rock from which the mineral can be extracted profitably with existing technology and under present economic conditions.

revegetation: The re-establishment and development of self-sustaining plant cover. On disturbed sites, human assistance will speed natural processes by seed bed preparation, reseeding and mulching.

right-of-way (ROW): The legal right for use, occupancy, or access across land or water areas for a specified purpose or purposes.

riparian: Land areas which are directly influenced by water. They usually have visible vegetative or physical characteristics showing this water influence. Streamsides, lake borders, or marshes are typical of riparian areas.

runoff: That part of precipitation that appears in surface streams. Precipitation that is not retained on the site where it falls and is not absorbed by the soil.

salinity: A measure of the amount of mineral substances dissolved in water.

scatter (archeological): Random evidence of prior disturbance that is distributed about an area rather than concentrated in a single location.

scoping: An early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action. Scoping may involve public meetings, field interviews with representatives of agencies and interest groups, discussions with resource specialists and managers, and written comments in response to news releases, direct mailings, and articles about the proposed action and scoping meetings.

sediment: Soil or mineral transported by moving water, wind, gravity, or glaciers, and deposited in streams or other bodies of water, or on land.

sediment load: The amount of sediment (sand, silt, and fine particles) carried by a stream or river.

sedimentary: Rock formed from fragments of pre-existing rocks (e.g. sandstone) or by precipitation from solution (e.g. limestone).

seismic: Pertaining to an earthquake or earth vibration, including those that are artificially induced.

seismic operations: Use of explosive or mechanical thumpers to generate shock waves that can be read by special equipment to indicate subsurface conditions.

sensitive species: Those species of plants or animals that have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species under the Endangered Species Act. This also includes species that are on an official state list or are recognized by the Land Manager as needing special management to prevent their being placed on federal or state lists.

sensitivity level: A particular degree or measure of viewer interest in the scenic qualities of the landscape.

shallow coal seam: Those coal seams that are too shallow to drill to directionally given the area geology and spacing limitations.

shut in: To close the valves on a well so it ceases production.

significant impact: A meaningful standard to which an action may impact the environment. The impact may be beneficial, adverse, direct, indirect, or cumulative, and may have short-term or long-term effects.

silt: Any earthy material composed of fine particles, smaller than sand but larger than clay, suspended in or deposited by water.

soil: Loose, unconsolidated surface material comprising topsoil and subsoil.

spawning: The deposition of eggs and sperm by fish.

species: (1) The classification level of biological nomenclature which categorized each group of related organisms potentially capable of interbreeding; (2) the accepted level of classification to differentiate one specific type of organism from another.

species of concern: Species of concern include federally listed threatened or endangered species, species proposed for listing, BLM sensitive species, and species considered rare or important by the Wyoming Natural Diversity Database (WYNDD).

spp.: An abbreviation for the plural of species.

spud: Begin drilling a well.

stipulation: A legal requirement, specifically a requirement that is part of the terms of a mineral lease. Some stipulations are standard on all federal leases. Other stipulations may be applied to the lease at the discretion of the surface management agency to protect valuable surface resources.

strata: An identifiable layer of bedrock or sediment; does not imply a particular thickness of rock.

substrate: Material consisting of silts, sands, gravels, boulder and woody debris found on the bottom of a stream channel.

surface lands: Lands consisting of the outside part of the solid earth or ocean as contrasted with subsurface or below surface land use(s) such as drilling and mixing.

threatened and endangered species: Any species, plant or animal, which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Threatened species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act.

topography: The features of the earth, including relief, vegetation, and waters.

topsoil: The uppermost layers of naturally occurring soils suitable for use as a plant growth medium.

total dissolved solids (TDS): Total amount of dissolved material, organic or inorganic, contained in a sample of water.

turbidity: A fisheries measurement of the total suspended solids in water expressed as nephelometric turbidity units (NTU).

usable water: Defined by Onshore Oil and Gas Order No. 2 as groundwater with a TDS of 10,000 ppm or less encountered at any depth.

vegetation: All of the plants growing in and characterizing a specific area or region; the combination of different plant communities found there.

vegetation type: A plant community with visually distinguishable characteristics, named for the apparent dominant species.

viewshed: Landscape that can be directly seen under favorable atmospheric conditions, from a viewpoint or along a transportation corridor.

visibility: A measurement of the maximum distance to which large objects may be viewed. Fixed reference objects such as mountains, hills, towers, or buildings are normally used to estimate visibility.

visual range: The distance at which a black object (in practice, a distant mountain) becomes indistinguishable to an observer.

visual resource: The composite of basic terrain, geologic features, water features, vegetation patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for viewers.

Visual Resource Management (VRM): A system of visual management used by the BLM. The program has a dual purpose, to manage the quality of the visual environment and to reduce the visual impact of development activities while maintaining effectiveness in all Bureau resource programs. VRM also identifies scenic areas that warrant protection through special management attention. The system uses five classes for categorizing visual resources.

> Class 1 - Natural ecological changes and very limited management activity are allowed. Any contrasts created within the characteristic landscape must not attract attention. This classification is applied to wilderness areas, wild and scenic rivers, and other similar situations.
>
> Class 2 - Changes in any of the basic elements (form line, color, texture) caused by a management activity should not be evident in the characteristic landscape. Contrasts are seen, but must not attract attention.
>
> Class 3 - Contrasts to the basic elements caused by a management activity are evident, but should remain subordinate to the existing landscape.
>
> Class 4 - Any contrast attracts attention and is a dominant feature of the landscape in terms of scale, but it should repeat the form, line, color and texture of the characteristic landscape.

Class 5 - The classification is applied to areas where the natural character of the landscape has been disturbed to a point where rehabilitation is needed to bring it up to one of the four other classifications. The classification also applies to areas where unacceptable cultural modification has lowered scenic quality; it is often used as an interim classification until objectives of another class can be reached.

water bar: A ridge made across a hill to divert water to one side.

water quality: Refers to a set of chemical, physical, or biological characteristics that describe the condition of a river, stream, or lake. The quality of water determines which beneficial uses it can support. Different instream conditions or levels of water quality are needed to support different beneficial uses.

Waters of the United States: A jurisdictional term from Section 404 of the Clean Water Act referring to water bodies such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce.

watershed: A topographically delineated area that is drained by a stream system, that is, the total land area above some point on a stream or river that drains past that point.

wellbore: The diameter of the hole to be drilled.

well head: The equipment used to maintain surface control of a well. It is composed of the casing head, tubing head and a series of valves and fittings.

well pad: Relatively flat work area that contains equipment and facilities used for oil/gas production.

wetlands: Areas that are inundated by surface or groundwater with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

Wilderness Study Area (WSA): An area determined to have wilderness characteristics. WSAs are submitted to the President and Congress for wilderness designation. These areas are an interim designation, valid until either designated as wilderness or released to multiple-use management.

wind rose: Any one of a class of diagrams designed to illustrate the distribution of wind direction experienced at a given location over a given period of time. Wind roses may also give information concerning distribution of wind speed, stability, or other meteorological parameters.

winter range: The place where migratory (and sometimes non-migratory) animals congregate during the winter season.

workover: Well maintenance activities that require onsite mobilization of a drill rig to repair the well bore equipment (casing, tubing, rods, or pumps) or the wellhead. In some cases, a workover may involve development activities to improve production from the target formation.

APPENDIX A

INTERIM DRILLING POLICY:

Development Authorized Concurrent with EIS Preparation for the Atlantic Rim Coalbed Methane Project

APPENDIX A

INTERIM DRILLING POLICY
DEVELOPMENT AUTHORIZED CONCURRENT WITH EIS PREPARATION
FOR THE ATLANTIC RIM COALBED METHANE PROJECT

During the preparation of the Atlantic Rim Coalbed Methane Environmental Impact Statement (EIS), the Bureau of Land Management's (BLM) authority to allow drilling on the federal mineral estate is limited. The Council on Environmental Quality (CEQ) Regulations and 40 CFR 1506.1, *limitations on actions during NEPA process* to comply with the National Environmental Policy Act (NEPA) provide the following regarding limitation on concurrent authorizations:

Section 1506.1

(a) Until an agency issues a record of decision as provided in para. 1505.2 (except as provided in paragraph (c) of this section), no action concerning the proposal shall be taken which would:

(1) Have an adverse environmental impact; or

(2) Limit the choice of reasonable alternatives.

(b) If any agency is considering an application from a non-federal entity, and is aware that the applicant is about to take an action within the agency's jurisdiction that would meet either of the criteria in paragraph (a) of this section, then the agency shall promptly notify the applicant that the agency will take appropriate action to insure that the objectives and procedures of NEPA are achieved.

(c) While work on a required program environmental impact statement is in progress and the action is not covered by an existing program statement, agencies shall not undertake in the interim any major Federal action covered by the program which may significantly affect the quality of the human environment unless such action:

(1) Is justified independently of the program;

(2) Is itself accompanied by an adequate environmental impact statement; and

(3) Will not prejudice the ultimate decision on the program. Interim action prejudices the ultimate decision on the program when it tends to determine subsequent development or limit alternatives.

(d) This section does not preclude development by applicants of plans or designs or performance of other work necessary to support an application for Federal, State or local permits or assistance....

The above regulations and the following criteria and conditions will be used by the BLM to determine new exploratory activities allowed on Federal surface and/or minerals during preparation of the EIS. They also establish conditions under which these activities will be approved. The intent of these criteria and conditions are to keep all activity within the scope of existing analysis and at a reasonable level, to allow limited drilling activity for acquisition of additional data necessary for completion of the EIS, and to prevent unnecessary hardship to

leaseholders. These criteria may be modified by the BLM authorized officer (AO) if any of the allowed activities are viewed as having a potentially significant effect on the environment or prejudice the ultimate decision on the drilling program for the EIS as outlined in the CEQ regulations quoted above.

ACTIVITIES ALLOWED ON FEDERAL LANDS AND MINERALS DURING EIS PREPARATION

1. A maximum of 200 coalbed methane wells will be allowed within the project area, for research and exploratory purposes, during the interim period in which the EIS is prepared. Wells will only be allowed in the nine pods the operators have proposed and a maximum of only 24 coalbed methane wells will be allowed within any pod, regardless of multiple zones to be evaluated (see map).

2. Activities within individual pods will be authorized by BLM. For any pod location which overlaps the boundary of a sensitive resource area for sage grouse, mountain plover, raptors, big game migration corridors, and sensitive plants, appropriate stipulations and mitigation will be applied to protect any sensitive resources present (see Term Definitions below). Some sensitive resources such as high density paleontological or cultural resources sites, are not mapped and will also be handled on a pod basis.

3. Existing coalbed methane wells (two wells re-completed as coalbed methane producers in the Cow Creek Unit by Double Eagle and one new well completed by Petroleum Development Corporation, to the east of this unit) will count toward the above well limits. As Federal 1691 #10-8 has been plugged and abandoned, it will not count toward the above well limit. In addition, the six coalbed methane wells originally permitted by North Finn LLC and drilled in Section 5, T. 17 N., R. 90 W., and the well located in Section 36 of T. 15 N., R. 91 W., will not count toward the allowed well number, as long as they are not included as part of any proposed pod. In addition, required injection wells and monitoring wells will not count toward the well limit.

4. Any modifications proposed to the approved pods (i.e. changing pod locations, drilling wells outside of the current pod locations, or increasing the total number of wells allowed during interim drilling), will only be approved if geologic, hydrologic, or reservoir characteristics support a change. These changes will be allowed after review by, and concurrence of, the Reservoir Management Group and authorization by the BLM, Rawlins Field Office. Additional federal drainage protection wells may be required.

5. During preparation of the EIS, coalbed methane wells and associated roads and pipelines on any private surface/private mineral where the operator has, or has obtained legal access (i.e., county roads, approved BLM ROW grant or private access road) prior to approval of the interim drilling plan, may be developed as deemed appropriate by the operator/lessee. However, these wells will count toward the total number of wells allowed to be drilled under this interim drilling policy.

THE FOLLOWING CRITERIA AND CONDITIONS APPLY TO INTERIM DRILLING OPERATIONS

1. A detailed Plan of Development/Surface Use Plan (POD/SUP) and Master Drilling Plan for each individual pod, using guidance provided by the BLM Rawlins Field Office, will be submitted and approved prior to surface disturbing activities.

2. The operator(s) agree to supply the geologic, coal, and water data information discussed in Attachment 1 of this document.

3. Prior to initiating interim drilling, an environmental assessment (EA), including a detailed Water Management Plan will be prepared and approved for each individual pod. Because of the current BLM workload, and in order to expedite the completion of the EAs, it is recommended that these documents be prepared by a third-party contractor.

4. All pod EA's will be submitted to the BLM in pdf format and each document will be placed on the BLM Wyoming web page. A 30-day public review of each document will be occur from the date the document is placed on the site. BLM will be responsible for writing the Decision Record for each EA.

5. A 1/4 mile buffer is required between surface disturbing activities and the Overland Trail.

6. Block surveys for cultural resources will be required for each pod.

7. No interim drilling will be allowed in the Sand Hills Area of Critical Environmental Concern as described in the Great Divide Resource Management Plan Record of Decision (RMP-1990).

8. The Great Divide RMP states the BLM will include intensive land-use practices to mitigate salt and sediment loading caused by surface disturbing activities within the Muddy Creek watershed. The Muddy Creek Coordinated Resource Management (CRM) group was established as an advisory group to address this issue. Because this area overlaps with the Muddy Creek CRM effort, and since road use contributes the most in increasing the amount of sediment in the Muddy Creek drainage, the POD/SUP will be reviewed by the Muddy Creek CRM Road Committee and recommendations of the group will be considered by BLM. Changes to the POD/SUP will be made prior to initiating work on the pod EA.

9. Surface discharge as a method of disposal for produced coalbed methane waters will be considered for each individual pod during interim drilling activities within the Great Divide Basin. This is subject to the approval of the Water Management Plan and upon obtaining all required federal, state and local permits.

10. Prior to completion of the EIS, water produced from coalbed methane wells located in the Colorado River Basin will be disposed of by re-injection. The only exception to this would be waters produced from the Double Eagle's coalbed methane existing and proposed wells located in the Cow Creek POD (POD #6). Double Eagle has applied to the Wyoming Department of Environmental Quality (WDEQ) for a National Pollutant Discharge Elimination System (NPDES) permit for their two existing wells and four wells permitted recently by BLM. Should Double Eagle receive their state permit, they will be allowed to surface discharge from these six wells. Prior to any additional drilling of CBM wells by Double Eagle in POD#6, an environmental assessment, including a Water Management Plan, will be prepared and submitted to BLM which will examine the environmental impacts from these wells. Double Eagle will be allowed to dispose of produced CBM waters to the surface only after completion of the environmental analysis and a determination is made that the additional surface discharge will cause no significant impact to the environment.

11. No drilling activities will be allowed in prairie dog towns during interim operations. However, drilling will be allowed in each individual pod containing prairie dog towns upon the completion of black-footed ferrets survey using methods approved by the United States Fish and Wildlife Service. These surveys will clear the pod for a one year period.

The operators also have the option of completing surveys in the whole EIS area which would clear the area for the life of the project.

12. In the event a black-footed ferret or its sign is found, the BLM Authorized Officer shall stop all action on the application in hand, and/or action on any application that may directly, indirectly, or cumulatively affect the colony/complex, and initiate Section 7 review with the USFWS. No project related activities will be allowed to proceed until the USFWS issues their biological opinion. The USFWS biological opinion will specify when and under what conditions and/or prudent measures the action could proceed or whether the action will be allowed to proceed at all.

13. No drilling or disturbance will be allowed in those areas determined to be critical winter habitat for sage grouse.

14. No drilling or disturbance will be allowed in areas where any two or more big game (elk, deer, or antelope) crucial winter ranges overlap.

15. The operators will be required to submit a drilling schedule as part of the Master Drilling Plan. This schedule will be reviewed, and approved by BLM, to ensure that activities are limited within proven big game migration corridors at critical use times during the year.

16. Pipelines, power lines, waterlines, fiber optic lines will be buried and, where possible, will follow the road rights-of-way.

17. Fish passage structures will be installed for roads which cross drainages with fisheries concerns as identified by BLM.

TERM DEFINITIONS

SENSITIVE RESOURCE AREAS are defined as those areas containing stabilized sand dunes, sensitive plant areas, raptor nesting concentration areas, prairie dog towns, two-mile buffer around sage grouse leks, mountain plover aggregation areas or potential habitat, big game migration corridors and crucial big game winter ranges, and areas with high density cultural or paleontological resource sites. Field inspections by the BLM will be conducted to verify presence of these resource values and potential impacts prior to considering authorization of any proposed development activity on Federal surface and/or minerals.

WILL BE AUTHORIZED means BLM will authorize the action if, following the environmental review of the APD or ROW application, sensitive resource areas are protected with appropriate stipulations or mitigation and the criteria established under CEQ regulation 40 CFR 1506.1 have been met. An environmental assessment (EA) will be completed for each individual pod prior to authorizing the proposal. Consultation and Coordination with the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service will occur when applicable for proposed activity within sensitive resource areas. The pod EA will identify the most environmentally acceptable access route, well site, and pipeline location. Mitigation measures developed from nearby project EISs and EAs for protection of resource values may be considered in the assessment. Any action proposed must be in conformance with the Great Divide Resource Management Plan (RMP) and mineral lease terms and conditions.

A coalbed methane pod may consist of two or more production wells, injection wells, access roads, product pipelines, water pipelines, power lines and other ancillary facilities designed specifically to assess the development potential of the play.

ATTACHMENT 1
DATA SUBMISSION REQUIREMENTS

A. GEOLOGIC AND COAL INFORMATION REQUIRED TO BE SUBMITTED BY OPERATORS DURING INTERIM DRILLING ACTIVITIES

The geologic and coal information needs identified below are those that the Reservoir Management Group, in consultation with the United States Geologic Survey, has determined are needed based on their experience with coalbed methane development in the Powder River Basin. The information will be used to define the potential gas resource and provide valuable data for the NEPA assessment including the determination of future development potential.

1. Operators will provide copies of all geologic information obtained to the Rawlins Field Office and the Reservoir Management Group as required under 43 CFR 3162.4.
2. The suite of logs required to evaluate coal beds in the project area are high resolution gamma ray, resistivity, density, and neutron logs. The full suite will be required during this phase but may be reviewed for changes during any later drilling phase.
3. Detailed geologic and coal information will be required and obtained for a minimum of one well within each of the nine pods. Information required includes; coal cores, fluid level, and production analysis. From this data information can be obtained on coal rank, adsorption and desorption gas content, core density, specific gravity, orientation of cleats and joints, initial saturations, coal permeability, and desorption pressure.
4. Initial reservoir pressure for each pod drilled.
5. Agree to standard stratigraphic nomenclature for all operators to use in preparing reports to the BLM and Wyoming Oil and Gas Conservation Commission.
6. Obtain an initial reservoir pressure for each coal bed in three of the pods.
7. Obtain reservoir pressure at the end of one year and two years, for each coal bed in three of the pods.

B. WATER ASSESSMENT/MONITORING DATA NEEDS

Recognizing that surface and ground water resources can be affected by large coalbed methane drilling projects, the following data submission requirements will be necessary to complete the assessment of impacts and develop baseline water conditions. Also water monitoring data has been found to be vital when reviewing drainage situations.

1. The operator(s) will obtain aquifer hydraulic baseline data for all pods in the initial exploration phase. This will include hydraulic conductivity and storativity derived from a multiple well pumping test conducted at each pod. This information could be used to provide data for the NEPA document and to assess monitoring needs for full field development.
2. Identify all domestic/industrial wells in the area and make a baseline and annual measurement of each.
3. Prepare a well mitigation agreement for existing wells and offer it to all groundwater appropriators in the vicinity.

4. Monitoring wells need to be installed both in an updip and downdip direction, completed in coal and overburden, from the pods selected. Details of this requirement will be done in coordination with the Rawlins Field Office hydrologist.

5. Measure initial static water levels in all production wells.

6. Collect water quality analyses for each pod.

7. Each well must have a continuous flow meter installed to measure water production rates for the duration of the project. All water production data will be furnished to the Bureau.

8. Baseline surface water quality should be collected in each stream or receiving water that will collect or transport discharge water. The analysis will include all BLM category I, II and III constituents.

9. The operator will provide to BLM a geologic map of the area/watershed where the produced water is to be re-injected. This should include surficial and bedrock geology, with a clear definition of recharge zones of the receiving formation/unit. The pre-injection water levels and water quality should be monitored and that data provided to BLM. The receiving aquifer should be pump tested and aquifer hydraulics reported to BLM. The reported parameters will include hydraulic conductivity, water levels and storativity for each receiving aquifer.

C. Additional Water Monitoring Requirements.

The following requirements were added to the interim drilling requirements effective January 14, 2002. Where there are conflicting monitoring requirements with those described in part B of this attachment, those listed below will supercede the previous requirements.

1. One pod in each distinct geologic setting will be selected for monitoring reservoir pressures with the required monitoring well program. The location of wells used in monitoring reservoir pressures will be determined through discussion with, and approval by, the Reservoir Management Group and the Rawlins Field Office.

2. One monitoring well will be drilled in each of the three selected pods which will allow all of the necessary data to be developed and available.

3. Take pressure reading from these wells every other month for the first year and then quarterly, or on a time frame as determined by the Resource Management Group. Data collected in each interval of the multiple completion groundwater monitoring well shall include an initial four-hour, formation-pressure measurement for each perforated interval. Subsequent, periodic pressure measurements for each perforated interval will be of at least a two-hour duration unless the interval has been open for more than two hours or if pressure buildup or decline suggest a different time interval.

4. Use of one of the proposed production wells to monitor reservoir pressure of the coal by obtaining initial pressure and annual shut-in bottom hole pressures.

This interim drilling policy is current as of a January 14, 2002. The activities, criteria, and conditions under which interim drilling are allowed are subject to change.

APPENDIX B

RECLAMATION PLAN

APPENDIX B

ATLANTIC RIM NATURAL GAS PROJECT RECLAMATION PLAN

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November 2004

APPENDIX B

ATLANTIC RIM NATURAL GAS PROJECT AREA RECLAMATION PLAN

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ATLANTIC RIM NATURAL GAS PROJECT AREA RECLAMATION PLAN

1.0 INTRODUCTION

The following erosion control, revegetation, mitigation, and management measures are designed to attain successful reclamation of disturbed areas associated with the Atlantic Rim Natural Gas Project Area (ARPA). These measures are designed to establish the feasibility of reclaiming disturbances associated with this project. The measures were developed based on: (1) Bureau of Land Management (BLM) Wyoming State Office reclamation policy (USDI-BLM 1990a); (2) management directives presented in the Great Divide RMP (USDI-BLM 1990b); (3) Wyoming Department of Environmental Quality, Land Quality Division reclamation guidelines, (4) impacts identified in the Environmental Consequences chapter (Chapter 4) of this environmental impact statement (EIS); (5) coordination with BLM staff; and (6) issues identified during the scoping process.

The extent of possible disturbed areas to be reclaimed include the drill pad sites, staging areas, access road and pipeline right-of-ways (ROWs). The following measures apply to the Proposed Action and to the No Action Alternative. The measures presented in this plan are designed to minimize the project's impacts to natural resources. Because of the large geographic area covered by the project and the lack of site-specific locations of project facilities, these measures are presented in a general, non-specific manner. Final selection of the measures to be applied at any given location, and modifications of these measures, will be identified by the BLM in coordination with the Operators.

This reclamation plan outlines measures that will be taken to effectively reclaim areas disturbed during the construction phase of the proposed project. These measures will be followed unless exceptions are granted or actions are modified by agreement between the BLM and the Operators. These measures describe how natural gas development activities should be managed to assure compliance with the resource management goals and objectives for the general area, applicable lease and unit area stipulations, and resource limitations identified during interdisciplinary team (IDT) analyses. Initial monitoring for compliance and successful implementation of the mitigation measures will be under the direction of the Operators. Final approval and release will be under the direction of the BLM.

Reclamation measures covered in this plan fall into two general categories: temporary and final reclamation. Temporary reclamation refers to measures applied to stabilize disturbed areas and to control runoff and erosion during time periods when application of final reclamation measures is not feasible or practicable. Final reclamation refers to measures that are to be applied concurrently with completion of drilling and pipeline installation.

Reclamation potential may be limited by soil chemical characteristics (e.g., salinity, alkalinity), physical characteristics (e.g., texture classification), altitude, aspect, slope, shallow soils, depth to bedrock, precipitation zone, length of growing season and seasonably high water tables. Special intensive land-use practices may be necessary to mitigate salt and sediment loading caused by surface-disturbing activities within the project area. Activity plans (e.g., applications for permit to drill [APDs]) should address site-specific issues and potential problems, including monitoring for salt and sediment loading (USDI-BLM 1990b).

In general, temporary reclamation measures should be applied to all areas that cannot be promptly reclaimed to final conditions within a specified time period whether due to adverse weather conditions, inability to secure needed materials, and/or seasonal constraints, etc.

Temporary reclamation measures should be applied only as needed; as in most cases, final reclamation measures should be applied concurrently as sections of the project are completed. Temporary reclamation measures may be applied more rigorously to sensitive areas such as drainage channel crossings, steep slopes, and areas prone to high wind and water erosion. Temporary reclamation measures should include re-grading the disturbed area to near pre-disturbance contour, re-spreading salvaged topsoil, mulching, and placement of runoff and erosion control structures.

Final reclamation measures, in general, involve re-grading the disturbed area to near pre-disturbance contour, re-spreading salvaged topsoil, applying soil amendments (if necessary), seeding a BLM-approved seed mixture, mulching, and placing runoff and erosion control structures such as water bars and silt fences. The duration of the resultant impacts to the various vegetation community types depends in part on the success of implementation of the reclamation measures prescribed in this plan and the time required for primary succession to return disturbed areas to pre-disturbance vegetation conditions.

Most of the surface water features in the project area qualify as Waters of the United States. Channels that carry surface flows and that show signs of active water movement are classified as waters of the U.S. Similarly, all open bodies of water (except ponds and lakes created on upland sites and used exclusively for agricultural and industrial activities or aesthetic amenities) are Waters of the U.S. [EPA 33 CFR § 328.3(a)] and are regulated by the Army Corps of Engineers (ACOE). Many ephemeral drainage channels identified on the USGS topographic maps for the ARPA are vegetated swales and are not considered to be Waters of the U.S. (ACOE 1987, 1992).

Any activity that involves discharge of dredge or fill material into or excavation of "Waters of the U.S." is subject to regulation by the ACOE pursuant to Section 404 of the Clean Water Act (CWA). The ACOE, based on the exact nature of the disturbance activity will determine the type of permit (Individual, Regional, or Nationwide) required according to the rules and regulations stated in the Federal Register (1986). Avoidance of Waters of the U.S. and wetlands should be a high priority. A suitable wetland mitigation plan should be developed for the areas of wetlands directly impacted due to project activities where avoidance is not practicable. Impact minimization should include reducing the area of disturbance in wetland areas as well as utilizing procedures specified by authorizing agencies to cross intermittent and ephemeral drainage channels and wetland areas. Activities that modify the morphology of stream channels are also subject to regulation by the Wyoming Department of Environmental Quality (WDEQ).

Residual wetland impacts that could occur after maximum avoidance and/or impact minimization have been demonstrated should be mitigated according to the following order of priority: (1) avoidance; (2) impact minimization; (3) mitigation in-kind, on-site; (4) mitigation in-kind, off-site; (5) mitigation out-of-kind, on-site; and (6) mitigation out-of-kind, off-site. In addition, the following modes of mitigation could be implemented for wetland mitigation if avoidance and impact minimization were not feasible: (1) wetlands restoration; (2) wetlands creation; and (3) wetlands enhancement. The wetlands mitigation plan should be designed to replace the area of impact and functional values associated with the disturbed area.

Appropriate BLM, Natural Resources Conservation Service (NRCS) range conservationists, and private seed companies were contacted to determine seeding recommendations at drill sites and along access road and pipeline ROWs. The reclamation measures in this report assume that baseline data (see Methods) will be collected at appropriate sites along the proposed access road and pipeline ROWs, staging areas, drill sites, and other potential construction-

related disturbed areas prior to construction by a qualified and authorized Operator representative.

Other criteria used in the seed mixture selection process included:

1. Seed availability and price, growth form, seasonal variety and prevailing dominant species;
2. contain no fewer than four (4) herbaceous species, unless a proposed land use (e.g. managed hayland or pastureland) requires fewer species;
3. contain the native dominant herbaceous species which support the post-disturbance land uses;
4. if needed, contain additional species native to the region which support the post-disturbance land uses;
5. contain naturalized, introduced species only if additional herbaceous species are needed, or if suitable, native species are unavailable or if naturalized species are superior for a specialized land use (e.g. managed hayland or pastureland);
6. contain full shrub and/or subshrub species when these species will support the post-disturbance land uses; and
7. contain native forb species if natural reestablishment of forbs will be limited by site-specific conditions.

2.0 OBJECTIVES

This plan is designed to meet the following objectives for reclamation of the access road/pipeline ROWs, staging areas, and the drill sites:

<u>Short-Term (Temporary) Reclamation:</u>

- Immediately stabilize the disturbed areas by mulching (if needed), providing runoff and erosion control, and through the establishment of new vegetation (required for problem areas; may be optional for other areas depending on consultation with the BLM).

- Control and minimize surface runoff, erosion, and sedimentation through the use of diversion and water treatment structures.

<u>Long-Term (Final) Reclamation:</u>

- Stabilize the disturbed soil surface by mulching (if needed and as directed by the BLM), runoff and erosion control, and through the establishment of new vegetation. Adequate surface roughness should exist to reduce runoff and to capture rainfall and snow.

- Control and minimize surface runoff, erosion, and sedimentation through the use of diversion and water treatment structures.

- Restore primary productivity of the site and establish vegetation that will provide for natural plant and community succession.

- Establish a vigorous stand of desirable plant species that will limit or preclude invasion of undesirable species, including noxious/invasive species.

- Reseed the disturbed areas with native plant species useful to wildlife and livestock.

- Enhance aesthetic values. In the long-term, reclaimed landscapes should have characteristics that approximate the visual quality of adjacent areas, including location, scale, shape, color, and orientation of major landscape undisturbed features.

3.0 PERFORMANCE STANDARDS

The following performance standards should be used to determine the attainment of successful revegetation:

<u>All Years:</u>

- <u>Protective cover</u>. With the exception of active work areas, all disturbed highly erosive or sensitive areas to be left bare, unprotected, or un-reclaimed for more than one month will have at least a 50 percent cover of protective material in the form of mulch, matting, or vegetative growth. All disturbed areas should have at least a 50 percent cover of protective material within six months after reclamation.

<u>Second Year (Final Reclamation):</u>

- <u>Seedling density</u>. The density and abundance of desirable species is at least three to four seedlings per linear foot of drill row (if drilled) or transect (if broadcast). Permanent vegetation transects will be established so that repeatable measurements can be conducted annually through the five year monitoring period.

- <u>Percent cover</u>. Total vegetal cover will be at least 50 percent of predisturbance vegetal cover as measured along the reference transect for establishing baseline conditions.

<u>By the Fifth Year (Final Reclamation):</u>

- <u>Percent cover</u>. Total vegetal cover will be at least 80 percent of predisturbance vegetal cover as measured along the reference transect for establishing baseline conditions.

- <u>Dominant species</u>. Ninety percent of the revegetation consists of species included in the seed mix and/or occurs in the surrounding natural vegetation, or as deemed desirable by the BLM as measured along the reference transect for establishing baseline conditions.

- <u>Erosion condition/soil surface factor</u>. Erosion condition of the reclaimed areas is equal to or in better condition than that measured for the reference transect for establishing baseline conditions.

4.0 METHODS

4.1 Drill Site, Access Road, and Pipeline Right-of-Way Clearing and Topsoil Removal and Storage

Topsoil should be handled separately from subsoil materials. At all construction sites, topsoil should be stripped to provide for sufficient quantities to be respread to a depth of at least four to six inches over the disturbed areas to be reclaimed. In areas where deep soils exist (such as floodplains and drainage channel terraces), at least 12 inches of topsoil should be salvaged.

Where soils are shallow or where subsoil is stony, as much topsoil should be salvaged as possible. Topsoil should be stockpiled separately from subsoil materials. Topsoil salvaged from drill sites and stored for more than one year should be bladed to a specified location at these areas, seeded with a prescribed seed mixture, and covered with mulch for protection from wind and water erosion and to discourage the invasion of weeds. Topsoil stockpiles should not exceed a depth of two feet. Topsoil should be stockpiled separately from other earth materials to preclude contamination or mixing and should be marked with signs and identified on Construction and Design plans. Runoff should be diverted around topsoil stockpiles to minimize erosion of topsoil materials. In most cases, disturbances will be reclaimed within one year. Therefore, it is unlikely that topsoil stockpiling for more than one year will be required. Salvaged topsoil from roads and drill sites will be respread over cut-and-fill surfaces not actively used during the production phase. Upon final reclamation at the end of the project life, topsoil spread on these surfaces will be used for the overall reclamation effort.

Operators are finding out that it is not always necessary to remove all vegetation and strip all topsoil within a pipeline ROW. In many areas, such as with deep soils on relatively flat smooth slopes with low gradients, it is possible to crush in-place rather than clear vegetation and leave topsoil in-place rather than blade and stockpile. This technique would reduce the magnitude and severity of disturbance impacts and hasten successful reclamation.

In federal jurisdictional wetland areas, vegetation should be cut off only to the ground level, leaving existing root systems intact. Cut vegetation should be removed from wetland areas for disposal. Grading activities should be limited to directly over pipeline trenches and access roads. At least 12 inches of topsoil should be salvaged and replaced except in areas with standing water or saturated soils. Use of construction equipment in wetland areas should be limited. Dirt, rockfill, or brush riprap should not be used to stabilize pipeline ROWs. If standing water or saturated soils are present, wide-track or balloon-tire construction equipment should be used or normal construction equipment should be operated on equipment pads or geotextile fabric overlain with gravel fill. Equipment pads etc., should be removed immediately upon completion of construction activities. Trench spoil should be placed at least 10 feet away from drainage channel banks for all minor and major drainage channel crossings.

4.2 Drill Site, Access Road, and Pipeline Right-of-Way Construction

4.2.1 Upland Areas

Uplands include all areas away from wetlands and alluvial bottomlands or other areas that have excess soil moisture for prolonged periods or have shallow water tables. Construction should be accomplished following site-specific Construction and Design plans and applicable agency specifications. At drill sites, and along the areas of access road or pipeline ROW traversing steep slopes, slope angles should be minimized to enhance retention of topsoil, and reduce erosion as well as facilitate revegetation and subsequent reclamation success. Slope stabilizing revetment structures may be necessary in areas where the substrata materials are unconsolidated and loose and cannot be stabilized with revegetation and mulch.

Surface runoff should be controlled at all well sites through the use of interception ditches and berms. A berm approximately 18 inches high should be constructed around fill portions of these well sites to control and contain all surface runoff generated or fuel or petroleum product spills on the pad surface. Water contained on the drill pads should be treated in a detention pond, prior to discharge, into undisturbed areas in the same manner as discussed previously. This system should also serve to capture fuel and chemical spills, should they occur.

Erosion and sedimentation control measures and structures should be installed on all disturbed areas. Soil erosion control should be accomplished on sites in highly erosive soils and steep areas with mulching, netting, tackifiers, hydromulch, matting, and excelsior. The type of control measure should depend on slope gradients and the susceptibility of soil to wind and water erosion. Silt fences should be placed at the base of all steep fill slopes and sensitive disturbed areas. All runoff and erosion control structures should be inspected periodically, cleaned out, and maintained in functional condition throughout the duration of construction and drilling. Water bars should be constructed on cut-and-fill slopes exceeding 25 feet long and 10 percent gradient using the water bar spacing guidelines and procedures specified for access road and pipeline ROW runoff and erosion control (BLM Manual 9113).

Runoff and erosion control along access road/pipeline ROWs should be accomplished by implementing standard cross drain, culvert, road ditch, and turnout design as well as timely mulching and revegetation of exposed cut, fill, and road shoulders. All culverts should be constructed with riprapped entrances and exits and with energy dissipaters or other scour-reducing techniques where appropriate. Water discharged from culverts, cross drains, road ditches and turnouts should be directed into undisturbed vegetation away from all natural drainages. Erosion and sedimentation control measures and structures should be installed across all cut-and-fill slopes within 100 feet of drainage channels. All runoff and erosion control structures should be inspected after major runoff events and at a regular schedule. If found to be sub-standard, these structures should be cleaned out and maintained in functional condition throughout the life of the project.

4.2.2 Drainage Channel Crossings

Construction of drainage channel crossings should minimize the disturbance to drainage channels and wetlands to the extent practicable and should occur during the low runoff period (June 15 through March 1). Staging areas should be limited in size to the minimum necessary and should be located at least 50 feet from drainage channel bottoms, where topographic conditions permit. Hazardous materials should not be stored and equipment should not be refueled within 100 feet of drainage channels. Drainage channel crossings should be constructed as perpendicular to the axis of the drainage channel and at the narrowest positions as engineering and routing conditions permit. Clean gravel should be used for the upper one foot of fill over the backfilled pipeline trenches within drainage channel crossings.

4.2.3 Wetlands

Access roads and pipelines should be rerouted, and drill sites located, to avoid wetland areas to the maximum extent practicable. The size of staging areas should be limited to the minimum necessary and all staging areas should be located at least 50 feet from the edge of federally delineated wetland areas, where topographic conditions permit. The width of the access road and pipeline construction ROW should be limited to no more than 50 feet. Hazardous materials should not be stored and equipment should not be refueled within 100 feet of wetland boundaries.

4.3 Surface Runoff and Erosion Control

4.3.1 Drill Site, Access Road, and Pipeline Right-of-Way

4.3.1.1 Temporary Reclamation

Temporary erosion control measures may include application of mulch and netting of biodegradable erosion control blankets stapled firmly to the soil surface, respreading scalped vegetation, or construction of water bars. See Final Reclamation measures (Section 4.6) for specific information pertaining to mulching.

The actual distance of a pipeline/road ROW requiring stabilization on each side of a drainage channel should be determined on a site-specific basis. To minimize sedimentation of drainage channels and wetlands during the interim period between construction activity and final reclamation, temporary erosion and sediment control measures should be applied. Silt fences or other sediment filtering devices such as weed-free straw bales should be installed along drainage channel banks where sedimentation is excessive and at the base of all slopes adjacent to wetlands. Figure C-1 presents schematics of water bar and silt fence construction. Sediment filtering devices should be cleaned out and maintained in functional condition throughout the life of the project. To avoid the possibility of mulching materials entering waterways, loose mulch (i.e., mulch not crimped into the soil surface, tackified, or incorporated into erosion control blankets) should not be applied to drainage channel banks.

If construction is completed more than 30 days prior to the specified seeding season for perennial vegetation, areas adjacent to the larger drainage channels should be covered with jute matting for a minimum of 50 feet on either side of the drainage channel. In addition, to protect soil from raindrop impact and subsequent erosion, 2.0 tons/acre of weed-free straw mulch should be applied to all slopes greater than 10 percent. Temporary erosion control measures may include leaving the ROW in a roughened condition, respreading scalped vegetation, or applying mulch. As indicated by several operators and the BLM, weed-free straw mulch is difficult to obtain in quantities and at costs suitable for all reclamation applications. Although this circumstance could reduce the application of the measure, the effectiveness of mulch in protecting the exposed soil from raindrop impact, erosion, and off-site sedimentation should not be ignored. In addition to its effectiveness in erosion control, mulching also benefits the soil as a plant growth medium in many cases. Therefore, effective mulching is fundamental to reducing soil erosion to acceptable, non-significant levels.

Trench breakers should be used for pipeline construction in certain areas to prevent the flow of water in either a trench that has been backfilled or temporarily left open. Trench breakers are particularly important in wetland areas to minimize subsurface drainage. Trench breakers should be constructed such that the bottom of one breaker is at the same elevation as the top of the next breaker down slope, or every 50 feet, whichever is greater. Factors that control the application of trench breakers include the proximity to drainage channels and wetland areas, slope gradient, proximity of areas to shallow groundwater, and surface runoff source areas that can discharge water into the trench. Trench breakers should be installed, where necessary. Topsoil should not be used to construct trench breakers.

If a pipeline crosses roads at the base of slopes, vegetative strips should be maintained. If vegetation is disturbed within these limits, temporary sediment barriers such as silt fences and/or staked weed-free straw bales should be installed at the base of the slope adjacent to the road crossing. Temporary sediment barriers should remain in-place until permanent revegetation measures have been judged successful.

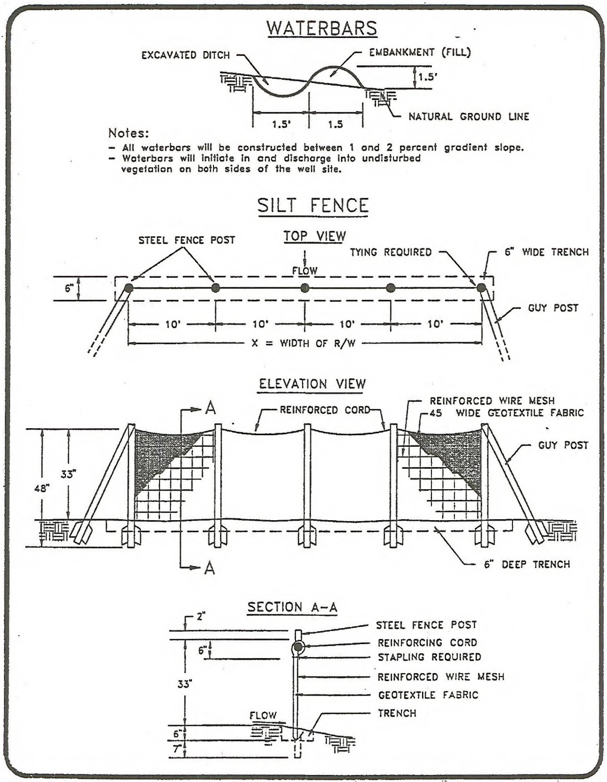

Figure C-1. Water Bar Construction and Silt Fence Construction.

4.3.1.2 Final Reclamation

4.3.1.2.1 Upland Areas

Runoff and erosion control along all ROWs should be accomplished by constructing sediment trapping devices (e.g., silt fences and straw bales) and water bars, as well as by timely mulching and revegetation of exposed disturbed areas. Runoff discharged from water bars should be directed into undisturbed vegetation away from all natural drainages. Erosion and sedimentation control measures and structures should be installed across all cut-and-fill slopes. All runoff and erosion control structures should be inspected after major runoff events and on a regular schedule. If found to be substandard or ineffective, these structures should be cleaned out and maintained in functional condition until successful revegetation and soil stability is attained.

Water bars should be constructed across sideslopes at appropriate intervals according to slope gradient immediately following recontouring of the disturbed areas. The spacing should depend on whether mulching is applied in conjunction with placement of water bars. Water bars should be maintained in functional condition throughout the life of the project. Should the integrity of the water bar system be disrupted during seeding, water bars should be repaired and broadcast seeded with the seed raked into the soil. Water bars should be constructed according to hillslope topography at the slope gradient intervals as shown in Table C-1.

Water bars should be constructed 12 to 18 inches deep by digging a small trench and casting the soil material to the downhill side in a row. Each water bar should initiate in undisturbed vegetation upslope, traverse the disturbed area perpendicular to the ROW at a gradient between one and two percent, and discharge water into undisturbed vegetation on the lower side of the disturbed area.

Table C-1. Water Bar Intervals According to Slope Gradient[1].

With Mulching		Without Mulching	
Slope Gradient (percent)	Interval (feet)	Slope Gradient (percent)	Interval (feet)
10	150	10	100
15	100	15	75
20	50	20	45
30	40	30	40
40	35	40	35
50	30	50	30
>50	30	>50	30

[1] Based on Grah (1989)

4.3.1.2.2 Wetlands and Drainage Channel Crossings

Disturbance to ephemeral and intermittent drainage channels should be avoided and/or minimized. All channel crossings not maintained for access roads should be restored to near predisturbance conditions. Drainage channel bank slope gradients should be regraded to conform with adjacent slope gradients. Channel crossings should be designed to minimize

changes in channel geometry and subsequent changes in flow hydraulics. Culverts should be installed for ephemeral and intermittent drainage channel crossings. All drainage channel crossing structures should be designed to carry the 25- to 50-year discharge event as directed by the BLM. Silt fences should be constructed at the base of slopes at all drainage channel crossings. Minor routing variations should be implemented during access road, pipeline, and drill site layout to avoid washes. The area of disturbance in the vicinity of washes should be minimized. Per the Great Divide Resource Area Resource Management Plan (RMP), a 500-foot-wide buffer strip of natural vegetation should be maintained between all construction activities and drainage channels.

Trench plugs should be employed at non-flumed drainage crossings to prevent diversion of drainage channel flows into upland portions of pipeline trenches during construction. Application of riprap should be limited to areas where flow conditions prevent vegetative stabilization; riprap activities must comply with ACOE permit requirements. Pipeline trenches should be dewatered in such a manner that no silt-laden water flows into active drainage channels (i.e., prior to discharge the water should be filtered through a silt fence, weed-free straw bales, or allowed to settle in a sediment detention pond).

4.4 Baseline Vegetation and Soil Inventory

Success of final revegetation goals is best determined by comparison with pre-disturbance conditions. The following recommendations are presented to assist the Operators (or designated agent) to collect the necessary data. During the APD process, exact disturbance locations are identified, described, and mapped. A baseline inventory of the vegetation on these locations will be conducted prior to the beginning of construction activities.

1. During the baseline inventory, the applicant delineates portions of vegetation types which will remain undisturbed and which are representative, in terms of physiography, soils, vegetation and land use history, of the plant community affected by soil disturbance activities. These undisturbed sites will serve as comparison sites for disturbed site impacts and final revegetation success. The representative nature of the comparison site is verified by statistical comparison (confidence level of 90%, $\alpha = 0.1$) of its absolute values of % vegetation cover, % total ground cover and total herbaceous production to similar data from the plant community it typifies. Species composition and species diversity are subjectively (non-statistically) evaluated. Quantitative pre-disturbance vegetation data from the reference site are directly compared, by standard statistical procedures (confidence level of 80%, $\alpha = 0.2$), to data from a reclaimed vegetation type when evaluating revegetation success. No mathematical climatic adjustment is made. Qualitative data are compared by standard procedures agreed to by the Operators and BLM.

2. During the baseline inventory, standard sampling methods are used to estimate the pre-disturbance values of the vegetation parameters on each affected vegetation type and an undisturbed portion of the same vegetation type. These pre-disturbance data are used to document the representative nature of the undisturbed unit. General inventory procedures, detailed quantitative sampling procedures, and estimating adequate sample size can be accomplished using several time-tested methods (USDI-BLM 1996, WDEQ 1984).

3. To assist in formulating a final revegetation seed mix, a plant species list will be constructed beginning with the baseline inventory. Field checks will be performed during June and August to ensure annual forbs are recorded (June) and late-maturing perennial grasses are correctly identified (August). Special attention should be given to identifying and recording the location of

all plant species of special concern, noxious/invasive weeds, and selenium indicator plants. *Artemisia* taxa will be identified to sub-specific level.

4. An adequate number of soil samples should be taken in each vegetation type encountered during the baseline survey. The seed mixtures shown in Table C-2 are based upon soil physical and chemical properties and it is imperative that the correct seed is matched to the parent soil to enhance revegetation success. Soil samples should be analyzed by an authorized soil testing laboratory for pH, soluble salts, organic matter, nitrate nitrogen, phosphorus, potassium, zinc, iron, copper, manganese, lime and soil texture. An additional test to determine the sodium adsorption ratio (SAR) may be required in questionable soils.

5. At least two (2) years prior to the end of the 5-year period, the revegetation success parameters are again estimated on the revegetated areas and the undisturbed units.

4.5 Noxious/Invasive Weed Management

On 3 February 1999, Executive Order (EO) 13112 ("Invasive Species") was signed by President Clinton. The primary purpose of this EO is to prevent the introduction of invasive species and provides for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. In Wyoming, some 428 species have been documented as invasive (Hartman and Nelson 2000). Of these 428 plants, 24 are designated as noxious by the State of Wyoming (Rice 2004) and are shown in Chapter 3 of this EIS (Table 3-26). In addition to these 24 state-designated species, Carbon County has designated halogeton (*Halogeton glomeratus*), plains prickly pear (*Opuntia polycantha*), Geyer larkspur (*Delphinium geyeri*), and lupine (*Lupinus* spp.) as noxious (Justensen 2004).

The presence, distribution, and density of noxious/invasive weeds on the project area will be monitored by the Operators. The well access roads, well pads, staging areas, and other project related soil disturbances will be inspected regularly to ensure that noxious/invasive weeds do not become established on newly disturbed sites. Control methods will be based on available technology, taking into consideration the weed species present. Methods of noxious/invasive weed control may include prompt revegetation of disturbed sites to reduce the potential for weed invasion, mowing, hand-pulling, or application of appropriate registered herbicides. The control methods shall be in accordance with guidelines, rules, laws, and regulations established by the Environmental Protection Agency (EPA), BLM (1991), and state/local authorities and agencies. Prior to initiating a weed management program, the Operators will obtain written approval from the BLM Authorized Officer. The Operators will also prepare and submit a proposal and plan to the BLM Authorized Officer for an annual weed program that satisfies the requirements established in the MSUP and any additional Conditions of Approval.

A concentrated effort will be required to manage the rapid invasion and expansion of halogeton (*Halogeton glomeratus*) that has occurred on much of the project area during the 2003 and 2004 growing seasons. Halogeton, an annual plant, is an aggressive invader of newly disturbed sites with alkaline to saline soils. Plant tissues accumulate salts from lower soil horizons. The salts leach from dead plant material, increasing topsoil salinity and favoring halogeton seed germination and establishment. Some salt in the foliage consists of soluble oxalates toxic to livestock, especially sheep. The threat of this plant to the livestock industry resulted in the Halogeton Glomeratus Act of 1952 (7 USC, Chapter 40, §§ 1651-1656). In addition to poisoning livestock, the ecological threats posed by the establishment of halogeton on the ARPA include: degradation of wildlife and livestock habitat; an increased salt load in the Upper Colorado River System; and reduction of native plant diversity and abundance.

Table C-2. Recommended General Seed Mixes for Disturbed Land Areas on the Atlantic Rim Natural Gas Project Area.

Plant Species	Scientific Name	Variety (if applicable)	Recommended Drill Seeding Rate[A]	Recommended Broadcast Seeding Rate[A]
SALINE/SODIC SOILS				
Western wheatgrass	*Pascopyrum smithii*	'Rosanna' or 'Arriba'	4.0	8.0
Sandberg bluegrass	*Poa secunda*		1.0	2.0
Slender wheatgrass	*Elymus trachycalum*	'Revenue' or 'Prior'	2.0	4.0
Indian ricegrass	*Achnatherum hymenoides*	'Nezpar' or 'Rimrock'	3.0	6.0
Bottlebrush squirreltail	*Elymus elymoides*		1.0	2.0
Alkali sacaton	*Sporobolus airoides*	'Salado'	0.75	1.5
Inland saltgrass	*Distichlis spicata*		1.0	2.0
Gardner's saltbush	*Atriplex gardneri*		2.0	4.0
Shadscale	*Atriplex confertifolia*		2.0	4.0
TOTAL			16.75	33.5
WETLAND/HIGH WATER SOILS				
Tufted hairgrass	*Deschampsia caespitosa*	'Nortran'	4.0	8.0
Basin wildrye	*Leymus cinereus*	'Trailhead' or 'Magnar'	6.0	12.0
American sloughgrass	*Beckmannia syzigachne*	'Egan'	3.0	6.0
Bluejoint reedgrass	*Calamagrostis canadensis*	'Sourdough'	1.0	2.0
Alkaligrass	*Puccinellia distans*	'Fults' or 'Salty'	0.75	1.50
Nebraska sedge	*Carex nebraskensis*		0.75	1.50
TOTAL			15.5	31.0
UPLAND SOILS				
Thickspike wheatgrass	*Elymus lanceolatus*	'Critana' or 'Bannock'	4.0	8.0
Western wheatgrass	*Pascopyrum smithii*	'Rosanna' or 'Arriba'	4.0	8.0
Indian ricegrass	*Achnatherum hymenoides*	'Nezpar' or 'Rimrock'	4.0	8.0
Sandberg bluegrass	*Poa secunda*		1.0	2.0
Bitterbrush[B]	*Purshia tridentada*		1.0	2.0
Scarlet globemallow	*Spaeralcea coccinea*		0.2	0.4
Winterfat	*Krascheninnikovia lanata*		2.0	4.0
Gardner's saltbush	*Atriplex gardneri*		1.0	2.0
Slender wheatgrass	*Elymus trachycalum*	'Revenue' or 'Prior'	2.0	
Wyoming or Basin big sagebrush[C]	*Artemisia tridentada wyomingensis* or, *A. t. tridentada*		0.2	0.4
TOTAL			17.2 - 19.4[D]	34.4 - 38.8

[A] Pure Live Seed (PLS), pounds/acre.
[B] Omit from seed mix in lower precipitation zones (<12 in.) or on sites where bitterbrush was not present prior to disturbance.
[C] If desired or required.
[D] Total pounds dependant upon saltbush, bitterbrush and sagebrush selections.

Because each plant produces vast number of seeds, some which may remain viable in the soil for ten years or longer, it is not practicable to eradicate any population that has been in existence for two years or more. However, halogeton is not competitive with vigorous perennial grasses and a major emphasis should be placed on prompt reseeding of disturbed sites, constant monitoring, and eradication of newly established spot infestations.

4.6 Final Reclamation

4.6.1 Topsoil Respreading and Seedbed Preparation

In preparation for seeding, topsoil that was initially removed should be evenly spread over the pipeline ROW, staging areas, cut-and-fill surfaces, and all areas of other sites not required for production purposes. Keep in mind that soil changes occur during storage. Chemically, the soil loses organic matter and fertility. Biologically, the number of microbes decrease with time and depth of burial. Earthworms decrease and viable seeds in the native seedbank are eliminated. Physically, soil aggregate stability is lost. If biological soil crusts were present before disturbance, the probability is high they will be negatively impacted during the topsoil removal, storage, and re-spreading process.

If construction operations allow, the Operators should consider the use of topsoil livehaul. Livehaul of salvaged soil eliminates the problems of stockpiling. Livehaul is the direct placement of freshly salvaged (not stockpiled) topsoil onto graded overburden in another area of operation. Consequently, deterioration of fertility, micro-flora, and seed viability are avoided.

Soil compaction usually results from heavy equipment working on disturbed soils prior to revegetation. Compaction can be minimized using single lift operations rather than repeatedly driving over the surface scraping off thin layers. Soil compaction can inhibit adequate revegetation of disturbance areas. Therefore, all disturbances to be revegetated should be ripped to reduce the adverse effect of compaction. All disturbed areas should be ripped on 18- to 26-inch spacing and 12 to 16 inches deep. A spring tooth harrow equipped with utility or seedbed teeth, or ripper-teeth equipment mounted behind a large crawler tractor or patrol should be used to loosen the subsoil. The subsoil surface should be left rough. After topsoil has been respread and if it is loose, it should be compacted with a cultipacker or similar implement to provide a firm seedbed. On steep slopes (greater than 40 percent and highly erosive), it may be difficult or impossible to replace topsoil and adequately prepare the seedbed. The disturbed areas on steep slopes should be ripped as described above. These areas should then be mulched with a hydromulch/seed/tackifier mix. Erosion control blankets with seed incorporated into the matting should be installed per manufacturer's specifications to enhance soil stabilization.

4.6.2 Seed Application

As stated in Section 2.4.3.7.2 of this EIS, the Operators will reseed all disturbed areas to landowner or BLM specifications. The following procedures are recommended to assure that all disturbed areas are stabilized and that revegetation efforts are enhanced so that impacts are minimized (USDI-BLM 1990a, 1997, 1999).

Scarification. Prior to reseeding, all compacted areas will be scarified by ripping or chiseling to loosen compacted soils. Scarification promotes water infiltration, better soil aeration and root penetration. Scarification will be done when soils are dry to promote shattering of compacted soil layers.

Seedbed Preparation. Appropriate seed bed preparation is critical for seed establishment. Seedbed preparation will be conducted immediately prior to seeding to prepare a firm seedbed conducive to proper seed placement and moisture retention. Seedbed preparation will also be performed to break up surface crusts and to eliminate weeds that may have developed between final grading and seeding. In most cases, chiseling is sufficient because it leaves a surface smooth enough to accommodate a tractor-drawn drill seeder and rough enough to catch broadcast seed and trap moisture and runoff. In low to moderate saline soils, a firm, weed-free seedbed is recommended. With high salinity levels, particularly when a high water table is involved, a fallow condition may not provide the best seedbed. If existing vegetation and weeds are chemically eradicated, the remaining dessicated roots and stems improve moisture infiltration and percolation, reduces evaporation from the soil surface, and protects emerging seedlings (Majerus 1996).

Seed Mixtures. Seed mixtures will be specified by the BLM on a site-specific basis prior to final reclamation and their selection will be justified in terms of local vegetation and soil conditions. Livestock palatability and wildlife habitat needs will be given consideration in seed mix formulation. The recommended general seed mixtures shown in Table C-2 were developed from observation of successful revegetation projects in the southwestern and south-central Wyoming regions and observation of dominant species in the project area. Recommended seeding rates are based on pounds pure live seed per acre (PLS/ac). PLS is calculated by multiplying the percent germination x percent purity of the seed lot divided by 100. All percentages are expressed as whole numbers (e.g. Wyoming big sagebrush – 12% purity x 75% germination = 12 x 75/100 = 9% PLS). Therefore, if the seed mix specifies a drill rate of 0.25 PLS/ac, the bulk seed required would be 0.25/0.09 = 2.8 lb bulk seed/ac. This amount would be doubled (5.6 lb bulk seed) for broadcast application.

These mixtures comply with Executive Order (EO) No. 11987 (Exotic Organisms). EO 11987 also specifies that use of any introduced plant species must have prior BLM approval for federal lands. BLM guidance for native seed use is BLM Manual 1745 (Introduction, Transplant, Augmentation, and Reestablishment of Fish, Wildlife, and Plants). The WGFD recommends that BLM consider shrub species in seed mixtures. On appropriate sites, BLM will coordinate with WGFD to insure that the correct shrub species are incorporated into seed mixtures on public lands.

Alternate Seed Mixes. Variations of the seed mixtures identified in Table C-2 may occur on a site-specific basis and will be specified by the BLM prior to final reclamation. An example for the ARPA would be the addition of green needlegrass (*Stipa viridula* var. *Lodorm*) on clayey sites associated with the southern portion of the project area (e.g., Muddy Mountain area).

Temporary Seed Mixes. Depending on BLM authorization, the following seed mixtures should be considered for erosion and weed control on sites that may be disturbed prior to final reclamation. The seed mixtures contain aggressive, non-native grasses that are not suitable for establishing a permanent and a diverse vegetative community but offer a temporary and competitive option to prevent halogeton invasion and establishment. The following temporary mixtures are suggested based on precipitation zone:

Semi-arid upland sites in the < 14 inches precipitation zone:

Bluebunch wheatgrass
Intermediate wheatgrass
Pubescent wheatgrass

Thickspike wheatgrass

Upland sites in the 14-22 inch precipitation zone:

Smooth brome
Paiute orchardgrass
Intermediate wheatgrass
Pubescent wheatgrass
Western wheatgrass
Thickspike wheatgrass
Alfalfa (dryland varieties)

Seed should be broadcast at the rate of 50 to 100 seeds per square foot, or 15 to 25 PLS pounds per acre. Another viable option is the use of a sterile triticale hybrid such as 'Quickguard®' (Granite Seed) to stabilize the disturbed area. The use of a non-sterile plant species such as wheat as a cover crop is not recommended because of its ability to reseed itself.

The seeded cover crop/stubble mulch is often an acceptable alternative to crimped (hay or straw) mulch. In fact, research (Schuman et al. 1980) has shown that cover crop/stubble mulch have several advantages over the use of crimped hay or straw mulch including: (1) decreased operation and application costs, (2) better wind and water erosion control, (3) increased water infiltration, (4) increased weed control, and (5) less temperature fluctuation at shallow soil depths.

<u>Shrub Selection</u>. For narrow and linear disturbance areas such as pipeline rights-of-way, the inclusion of native shrub seed is usually omitted from the seed mix given that a neighboring seed source is nearby and that natural shrub re-invasion and establishment will eventually return shrub density to pre-disturbance conditions. On larger disturbances the addition of a native shrub seed mix to the final seed mixture may be required to return shrub density to a pre-disturbance condition because of wildlife concerns. Commercial seed sources for most of the native shrubs found on the ARPA (e.g., Gardner's saltbush, greasewood, shadscale, winterfat, antelope bitterbrush, chokecherry, snowberry, etc.) are commercially available as well as seed for most of the big sagebrush sub-species complex (Basin, Wyoming, Vaseyana ssp.).

When specified in the final seed mixture, it is recommended that sagebrush sites be re-seeded with an identical species/sub-species identified during the pre-disturbance baseline plant inventory. Whenever possible, select seed of northern, locally adapted ecotypes. Map C-1 (from HWA 2004; will be completed when BLM's data is received) delineates the distribution of the major sagebrush taxa found on the ARPA and may serve as a general guide in the construction planning process. It is anticipated that the majority of natural gas construction and development activities on the ARPA will occur within the lower elevation Wyoming big sagebrush cover type, however, several secondary sagebrush cover types may be intermixed within this major zone. An example is the northwestern portion of the project area where smaller sub-communities of intermediate forms of basin big sagebrush are intermixed within the Wyoming big sagebrush primary cover type and occupy the many draws and swales where deeper soils and moisture availability exist. The various *Artemisia* taxa have very specific requirements for establishment and growth (e.g., sandy soils near the Sand Hills area support Plains silver sagebrush whereas clayey soils in the southern portion of the ARPA support early (= alkali) sagebrush). The baseline plant inventory should identify and describe *Artemisia* taxa on proposed disturbed sites to a sub-specific level.

Timing of Seeding. Fall seeding will occur from about September 15 until ground freeze or snow pack prevents critical seed soil coverage. The optimum time to seed a forage or cover crop in saline-alkaline soils is late fall (mid-October to December) or during a snow-free period during the winter (Majerus 1996). Ideally, in saline-alkaline soils, the seed should be in the ground before the spring season so that it can take advantage of the diluting effects of early spring moisture. Spring seeding will be completed by 15 April or as directed by the BLM. An extension to 15 May usually entails minimal risk of failure in most years. Seed will be used within 12 months of testing. The actual choice of seeding time should be based on regional climatic conditions, site-specific environmental conditions, and operator preference and experience.

Seeding Method. Drill seeding will be used where the terrain is accessible by equipment. The planting depth for most forage species is 1/4 to 1/2 inch (5-10 mm). A double disk drill equipped with depth bands, a seed agitator, and packer wheels ensures optimum seed placement. The seed should be separated by boxes to prevent seed from separating due to size and weight. Rice hulls or other appropriate material will be added to the seed as necessary to prevent separation. The drill will be properly calibrated so that seed is distributed according to the rates specified for each seed mix. If a sagebrush/grass mix is used, it is recommended to partition the seed boxes and drill to allow the slower developing shrub seeds to be planted in separate rows from the more rapidly developing grass and forb seeds. In areas where the goal is to simulate a natural appearance, the site should be drilled in multiple, cross, over-lapping patterns. This will eliminate the row crop appearance of the site.

Broadcast seeding may be used on areas too steep for drill seeding or where approved by the BLM. Broadcasted seed should occur onto a rough seedbed and then should be lightly harrowed, chained or raked to cover the seed. The seeding rate should be doubled for the recommended mixtures because the mixtures were developed for drill seeding. The method used to cover the seed should be selected so that the seed is lightly covered but maintains the surface in rough condition. The broadcast seeder should be properly calibrated or the seeding should occur over a calculated known area so that the proper seeding rate is applied.

The Operators are strongly encouraged to consider staggered seeding methods to facilitate the establishment of shrubs and/or to revegetate areas with poor quality substrates (e.g. see Coenenberg 1982, De Puit 1982). Small seeded species (e.g. big sagebrush) establish best when the seed is broadcast and lightly covered.

Any soil disturbance that occurs outside the recommended permanent seeding season, or any bare soil left unstabilized by revegetation, should be treated as a winter-construction problem and mulching should be considered, or the site stabilized. Watershed protection must be emphasized when reclaiming disturbed areas. The composition of rare and native species, if encountered, should be taken into consideration at the time of seeding; however, appropriate measures must be taken to ensure that an adequate protection of the soil surface is maintained. Areas not exhibiting successful revegetation throughout the entire area disturbed by the project should be re-seeded until an adequate cover of vegetation is established. Private and agricultural lands should be seeded with similar seed mixes unless the landowner requests different mixes.

4.6.3 Mulching

In sensitive sites where significant erosion (e.g., large areas of disturbance or areas with high erosion rates) is most likely to occur, the seeded access road/pipeline ROW, staging areas, and

the portion of the drill pads not needed for production purposes should be mulched following seeding to protect the soil from wind and water erosion, noxious/invasive weed invasion, and to hold the seed in place. The exposed surface of disturbed areas, including topsoil stockpiles, may be protected by placing crimped straw mulch, hydromulch, biodegradable plastic netting and matting, or biodegradable erosion control blankets.

All sensitive disturbed areas should be mulched immediately following seeding with 1.5 to 2.0 tons/acre of a weed-free straw mulch. Mulching materials should be free of noxious/invasive weed species as defined by state and/or county lists. Hay mulch may be used, but it should be applied only if cost-competitive and if crimped into the soil. Straw mulch is more desirable than hay mulch because it is generally less palatable to wild horses, wildlife, and livestock. Additionally, there tends to be a higher risk of introducing undesirable species with a hay mulch such as smooth brome, timothy, orchardgrass and other minor species. The lessee should maintain all disturbances relatively weed-free for the life of the project through implementation of a noxious/invasive plant species management program.

Wherever utilized, mulch should be spread uniformly so that at least 75 percent of the soil surface is covered. If a mulch blower is used, the straw strands should not be shredded less than eight inches in length to allow effective anchoring. On slopes less than 30 percent, straw mulch should be applied by a mechanical mulch blower at a rate of 2.0 tons/acre after seeding. The mulch should be crimped into the soil surface using a serrated disc crimper. Where broadcast straw mulch is applied on windswept slopes, a biodegradable plastic netting should be staked firmly to the soil surface over the mulch following the manufacturer's specifications. On slopes in excess of 40 percent or on slopes exceeding the operating capabilities of machinery, hydromulch or biodegradable erosion control blankets with seed incorporated into the netting should be applied and staked firmly to the soil surface.

Where utilized, hydromulch and tackifier should be applied at a rate of 1,500 lbs/acre. In general, erosion control and soil stabilization are directly related to the amount of mulch applied. Under certain conditions where degradation processes are slow (e.g., in extremely hot or cold dry climates), a trade-off between the degree of effectiveness of mulch and long-term degradation should be considered. In extremely dry areas where mulch degradation may be slow, mulching rates should be reduced to 1.0 to 1.5 tons/acre. Special measures may need to be implemented in areas with sandy soils.

On steeper slopes with highly erodible, shallow, rocky soils and/or on windswept areas with loose, unconsolidated materials, the above recommended measures may not be sufficient to reduce erosion to non-significant levels. The following measure should be considered by the operator and the BLM to stabilize such sites: incorporating a custom blend of seed into erosion control blankets. This method has proven cost-effective in many cases, with 98 percent of the cost being the blanket itself. The additional cost of incorporating seed into the blanket will average $1.00 to $1.50 per blanket, depending upon current seed costs. In most cases, this additional cost should offset the repeated efforts of broadcast seeding, manual raking of seeds into the soil, and mobilizing a labor force. The final measure(s) to be implemented in such areas should be determined by agreement between the BLM and Operators.

4.6.4 Grazing Management

New seedlings must be protected from grazing until they are well established. Generally, grazing should be deferred at least until the first seed crop has matured. On public lands, the deferment period will be established by the BLM. Livestock grazing should be monitored on and

along all drill sites, access road and pipeline ROWs. Should grazing negatively impact revegetation success, measures should be taken to exclude livestock from the newly reclaimed areas. Depending upon site-specific evaluations, it may be necessary to temporarily fence off certain riparian areas and wetlands to prevent excessive livestock grazing and trampling to enhance drainage channel bank stabilization and overall revegetation success. Existing livestock control structures such as fences and cattle guards should be maintained in functional condition during all phases of the project. Where access requires the disruption of an existing fence, a cattle guard should be installed at the junction.

4.6.5 Off-Road Vehicle Management

Off-road vehicle control measures should be installed and maintained following the completion of seeding. Examples of practicable measures include a locking, heavy steel gate with fencing extending a reasonable distance to prevent bypassing the gate, with appropriate signs posted; a slash and timber barrier; a pipe barrier; a line of boulders; or signs posted at all points of access at intervals not to exceed 2,000 feet indicating "RECLAMATION AREA, NO MOTORIZED VEHICLES ALLOWED BEYOND THIS POINT."

4.6.6 Dust Abatement Management

Should fugitive dust created during construction of drill sites, access road/pipeline ROWs, or staging areas become a problem, dust abatement measures should be implemented. Dust abatement using produced water will comply with all applicable WOGCC, WDEQ, or BLM requirements. Only water suitable for livestock use should be used for dust abatement and only disturbed areas should be sprayed. Spraying should be conducted in a manner that will reduce runoff and channeled flow.

4.7 Monitoring and Maintenance

4.7.1 General

A designated official or responsible party should annually inspect and review the condition of all drill sites, access road/pipeline ROWs, and any other disturbed areas associated with the project. This official should assess the success and effectiveness of all runoff and erosion control and revegetation efforts, evaluate fugitive dust control needs, and recommend remediation measures, if necessary. In addition, monitoring should take place following each major runoff event. Photographs should be taken at drill sites and along access roads at specific areas each year to document the progress of the reclamation program at established photomonitoring points.

The following specific items should be evaluated during the monitoring process:

- revegetation progress;
- evidence of sheet and rill erosion, gullies, slumping, and subsidence;
- soundness and effectiveness of erosion control measures;
- sediment filtering devices along all active ephemeral and intermittent drainage channels;
- water quality and quantity;

- noxious/invasive weed species invasion and establishment;
- degree of rodent damage on seed and seedlings;
- locations of unauthorized off-highway vehicle (OHV) access;
- soundness and effectiveness of OHV control structures;
- degree of livestock grazing and wildlife browsing; and
- overgrazing/trampling of riparian and wetland areas.

4.7.2 Reclamation Success Monitoring

Reclamation success should be based upon the objectives specified in this plan; therefore, monitoring should be tied to these objectives. The actual monitoring procedures for quantitative and qualitative evaluations of reclamation success should be implemented as specified by the BLM or other authorizing agencies.

Reclamation success should be monitored both in the short term (temporary reclamation) and in the long term (final reclamation). Monitoring of temporary reclamation measures should include visual observations of soil stability, condition, and effectiveness of mulching and runoff and erosion control measures and a quantitative and qualitative evaluation of revegetation success, where appropriate. Long-term reclamation monitoring should include visual observations of soil stability, condition of the effectiveness of mulching and runoff and erosion control measures, and a quantitative and qualitative evaluation of revegetation success.

Revegetation success will be determined by the BLM. In general, reclamation success should include the following qualitative and quantitative vegetation parameters:

1. % vegetation cover (absolute value).
2. % total ground cover (absolute value).
3. Density of shrub and sub-shrub species.
4. Areal extent of shrub mosaics.
5. Number of trees (If present).
6. Species diversity and species composition.
7. Attainment of these parameters during the last two consecutive years of the five-year period.

Below normal annual precipitation for an extended time during the five-year period may prevent these goals from being realized and should be documented and accounted for.

The pre-disturbance values of these parameters, estimated from the vegetation types actually affected by energy-related disturbances and/or from other undisturbed portions of the same type which are representative of the affected vegetation types, are used to generate the post-disturbance, long-term revegetation success goals. The baseline vegetation inventory should generate a single quantitative or qualitative value for parameters 1, 2, 3, 5 and 6 from each vegetation type and its representative reference transect. Each quantitative and qualitative goal should be clearly presented in the final reclamation plan agreed to by the Operators and the BLM.

Soil stability should be measured using an erosion condition class/soil surface factor rating method to numerically rate soil movement, surface litter, surface rock, pedestalling, flow patterns, and rill-gully formation. Information obtained through this rating system represents an expression of current erosion activity and can be used to reflect revegetation success as a function of soil stability. Grazing impacts should be assessed as an ocular estimate of the percent utilization along the transect.

The access road boundaries, pipelines, and unused portions of the drill sites should be monitored until attainment of 80 percent of predisturbance vegetative cover within five years of seeding. This standard should include 90 percent of the vegetative cover being comprised of desirable species and the erosion condition of the reclaimed area being equal to or in better condition than predisturbance conditions as prescribed under the Performance Standard section of this plan.

4.7.3 Wetland and Drainage Channel Crossings

Wetland areas and natural drainage channel crossings should be monitored for a minimum of three years for the presence of noxious or other undesirable invasive weeds. Noxious/invasive species should not be allowed to establish at any time. If found in a reclaimed wetland or drainage channel crossing, the noxious/invasive species should be removed. Undesirable species should not be allowed to establish. At the third year of monitoring, presence of undesirable species should be negligible. The lessee should maintain wetland areas and drainage channel crossings according to this standard throughout the development of a noxious/invasive weed species management program recommended by the BLM and/or the Carbon County Weed and Pest Control District Supervisor. Herbicide(s) used in wetland/riparian areas must be labeled for aquatic use and applied in accordance with label requirements. .

4.7.4 Photomonitoring

Permanent photo-monitoring points should be established at appropriate vantage locations that provide adequate visual access to drill sites, along pipeline and access road rights-of-way, and to ancillary facilities. Photos should be taken at each photo-monitoring point prior to initiation of construction through coordination with the Operator and BLM. Each photo-monitoring point should be permanently marked with a six-foot steel post driven in the ground to the top of the anchor plate. The use of rebar is not recommended because of safety concerns (e.g., future mowing projects and possible damage to equipment/truck tires). It is recommended that the top of the steel post serve as the photopoint to ensure photograph accuracy and repeatability. Each photo-point location should be recorded using Global Positioning System (GPS) technology. It is recommended the location be recorded as Universal Transverse Mecator (UTM) coordinates utilizing the CONUS NAD27 map datum. The UTM coordinates of each photo-point should be displayed and specifically identified on a GIS-generated topographic map of the area and made available to the Operators and BLM on a regular basis to reflect changes as the project develops.

Photos should be taken with a high-resolution digital camera to increase efficiency of processing and image storage. All photos should be archived in electronic format on CD-ROM. If a conventional 35 mm format camera is used, the film should be processed by the developing firm and the images saved to a CD-ROM. Each photo should be labeled with the photo-point GPS location, time, and date. This is easily done using the "text" function common to all photo-processing software programs or accomplished in the field by incorporating the necessary information written on a dry-erase board with the photograph. Hardcopy images of the

photographs should be printed in a 10 x 7 inch landscape format and used in the field to frame and duplicate succeeding photos. Photos should be taken annually until reclamation standards have been met. To minimize interpretation errors, photos should be taken approximately the same week each year if possible. During the summer months, vegetation detail (e.g., color and hue) is greatly enhanced if the photo is taken before 1000 hours or after 1500 hours. A polarizing filter is recommended for afternoon, bright sun conditions.

REFERENCES CITED

Army Corps of Engineers (ACOE). 1987. Wetland delineation manual. Environmental Laboratory Tech. Rept. Y-87-1 (on-line version), U.S. Army Engineers Waterways Exp. Sta., Vicksburg, MS.

ACOE. 1992. Memorandum - clarification and interpretation of the 1987 manual, 6 March 1992, Dept. of Army, Washington, DC.

Coenenberg, J.G. 1982. Methods for establishment of diverse native plant communities at the Rosebud Mine. Research Report 194. Montana Agricultural Experiment Station. Bozeman, MT.

DePuit, E.J. 1982. Cool season, perennial grass establishment on Northern Great Plains mined lands: status of current technology. Research Report 194. Montana Agricultural Experiment Station. Bozeman, MT.

Grah, O.J. 1989. Use of MSLE for determination of attainment of performance standards for a proposed ski area. "Erosion Knows No Boundaries", Proc. of Conf. XX, International Erosion Control Association, Feb. 15-18, Vancouver, BC, Canada.

Hartman, R. L., and B. E. Nelson. 2000. Working list of invasive vascular plants of Wyoming. (http://www.mh.uwyo.edu)

Hayden-Wing Associates (HWA). 2004. Unpublished Draft - Distribution and description of *Artemisia* taxa on the Atlantic Rim Natural Gas Project Area. Laramie, WY.

Justensen, L. 2004. Supervisor, Carbon County Weed and Pest District. Personal conversation with Larry E. Bennett, Hayden-Wing Associates, July 2004.

Majerus, M. 1996. Plant materials for saline-alkaline soils. USDA-NRCS, Bridger Plant Materials Center, Bridger, MT. (www.animalrangeextension.montana.edu).

Rice, P. M. 2004. INVADERS Database System Division of Biological Sciences, University of Montana, Missoula, MT. (http://invader.dbs.umt.edu)

Schuman, G.E., E.M. Taylor, F. Rauzi and G.S. Howard 1980. Standing stubble versus crimped straw mulch for establishing grass on mined lands. J. of Soil and Water Conserv. 35(1): 25-27.

U.S. Department of the Interior, Bureau of Land Management (USDI-BLM). 1990a. Wyoming policy on reclamation. BLM-Wyoming State Office, Cheyenne, WY.

USDI-BLM. 1990b. Great Divide Resource Area record of decision and approved resource management plan. BLM-WT-PT-91-010-4410, USDI-BLM, Rawlins Field Office, Rawlins, WY.

USDI-BLM. 1991. Final environmental impact statement – vegetation treatment on BLM Lands in Thirteen Western States. USDI, BLM-WY-ES-91-022-4320.

USDI-BLM. 1996. Sampling vegetation attributes. BLM/RS/ST-96/002+1730. National Applied Science Center, Denver, CO.

USDI-BLM. 1997. Green River Resource Management Plan. Rock Springs Field Office, Rock Springs, WY. Available online @ (http://newweb.ead.anl.gov/rmpweb/application/rmp).

USDI-BLM. 1999. Draft environmental impact statement for the Pinedale anticline oil and gas exploration and development project. BLM/WY/PL-00/003 + 1310, BLM, Pinedale Field Office, Pinedale, WY.

Wyoming Department of Environmental Quality (WDEQ). 1984 (Updated 8/94). Guideline No. 2 - vegetation. WDEQ, Land Quality Division, Cheyenne, WY. Available online @ http://deq.state.wy.us/deq (follow "guideline" link).

APPENDIX C

HAZARDOUS MATERIALS MANAGEMENT PLAN

APPENDIX C

HAZARDOUS MATERIALS MANAGEMENT PLAN

INTRODUCTION

This Hazardous Materials Management Plan is provided pursuant to Bureau of Land Management (BLM) Instruction Memoranda Numbers WO-93-344 and WY-94-059, which require that all National Environmental Policy Act (NEPA) documents list and describe any hazardous and/or extremely hazardous materials that would be produced, used, stored, transported or disposed of as a result of a proposed project. Hazardous materials, as defined herein, are those substances listed in the Environmental Protection Agency's (EPA's) *List of Hazardous Substances* (40 Code of Federal Regulations [CFR] Part 302) and extremely hazardous materials are those identified in the EPA's *List of Extremely Hazardous Substances* (40 CFR Part 355). For purposes of this discussion, compounds included in the Clean Air Act Section 112(r) List of Substances for Accidental Release Prevention (40 CFR Part 68) are also considered hazardous materials. Materials identified on any of these lists that are expected to be used or produced by the proposed project are discussed herein.

A list of hazardous and extremely hazardous materials that are expected to be produced, used, stored, transported or disposed of as a result of exploration and production operations was assembled. Where possible, the quantities of these products or materials have been estimated on a per-well basis.

Some potentially hazardous materials that may be used in small, unquantifiable amounts have been excluded from this Management Plan. These materials may include:

- wastes, as defined by the Solid Waste Disposal Act;
- wood products, manufactured items and articles which do not release or otherwise result in exposure to a hazardous material under normal conditions of use (i.e., steel structures, automobiles, tires, etc.); and
- food, drugs, tobacco products and other miscellaneous substances (i.e., WD-40, gasket sealants, glues, etc.).

Project personnel will be directed to properly manage and dispose of hazardous materials. Solid wastes generated at well locations will be collected in approved waste facilities (e.g., dumpsters). Each well location will be provided with one or more such facilities during drilling and completion operations. Solid wastes will be regularly removed from well locations and transported to an approved disposal facility.

HAZARDOUS MATERIALS

Materials produced, used, stored, transported or disposed of during the exploration and production phases of the project may be hazardous or may contain hazardous constituents. The following discussion will address the hazardous substances generally associated with the lifecycle of a coalbed methane well.

PRODUCTION STREAMS

The purpose of the proposed project is to extract natural gas primarily from the Mesaverde Coal formation, with other deep formations targeted as well. Water, and perhaps, liquid hydrocarbons will be produced as a result of the extraction operations. Table C-1 lists and

quantifies, where possible, the hazardous and extremely hazardous substances that may be found in the production streams.

Natural Gas

Natural gas will be produced from approximately 1800 coalbed methane and, perhaps, conventional wells within the boundaries of the project at an average rate of 0.2 million cubic feet per day (mmcfd) per well. The natural gas produced from the wells will primarily contain methane, ethane, nitrogen and carbon dioxide. Hexane, polynuclear aromatic hydrocarbons (PAHs) and polycyclic organic matter (POM) are hazardous substances that may potentially be present in the gas stream. No other hazardous substances are known to occur within the natural gas stream.

The natural gas produced from the project area wells will be transported from each location through newly constructed pipelines linking well locations to existing or newly constructed centralized production facilities. Natural gas storage facilities are not expected to be utilized.

Produced Water

Produced water from wells within the project boundaries is expected to average 200 barrels per day (bpd) per well. Produced water quality from the wells within the project area is variable and will be monitored periodically. Water from the Mesaverde Coal and other targeted formations is known to contain the following hazardous substances:

Antimony	Copper	Selenium
Arsenic	Cyanide	Silver
Barium	Lead	Sodium
Beryllium	Mercury	Thallium
Cadmium	Nickel	Zinc
Chromium	Radium 226	

Phenol, an extremely hazardous substance, is also found in the produced water stream. No other hazardous or extremely hazardous materials are known to be present.

Produced water will be stored in tanks at centralized production facilities and disposed through Wyoming Department of Environmental Quality (WDEQ) or Wyoming Oil and Gas Conservation Commission (WOGCC) permitted water disposal systems. Produced water quality from wells will be monitored periodically and produced water that meets applicable standards may be discharged to the surface at appropriate locations. Agency authorizations that must be obtained prior to the disposal of produced water include:

- BLM approval of disposal methodologies;
- WDEQ Water Quality Division approval of wastewater disposal (e.g., National Pollution Discharge Elimination System permits and Underground Injection Control permits);
- WOGCC evaporation pond permits; and
- Wyoming State Engineer's Office (WSEO) dewatering permits.

Liquid Hydrocarbons

Condensate or other liquid hydrocarbon production associated with the natural gas stream is not expected from productive coalbed methane wells in the project area. However, should

any liquid hydrocarbon be produced, the stream would typically contain the following hazardous substances:

Benzene	POM
Ethylbenzene	Toluene
n-Hexane	Xylenes
PAHs	

No extremely hazardous materials are expected to be present in the liquid hydrocarbon stream.

Liquid hydrocarbons, if produced, will be stored in tanks at centralized production facilities. The tanks will be fenced and bermed to contain the entire storage capacity of the largest tank plus one foot of freeboard as mandated by the BLM. Liquid hydrocarbons, if produced, will be periodically removed from the storage tanks and transported via truck, in adherence to DOT rules and regulations, outside the project area. Necessary Regulatory approvals for the production, storage and transport of liquid hydrocarbons, including the Oil Pollution Act of 1990 (storage of >1,000,000 gal), will be addressed prior to the initiation of liquid hydrocarbon production activities.

EXPLORATION AND PRODUCTION ACTIVITIES

Exploration and production activities associated with the project area will include geophysical, construction, drilling, testing, completion, production, maintenance, transportation, abandonment, and reclamation components.

Known hazardous and extremely hazardous materials typically utilized during exploration and production operations in the project area are listed in Table C-1 and generally fall into the following categories:

- fuels;
- lubricants;
- coolant/antifreeze and heat transfer agents;
- drilling fluids;
- fracturing fluids;
- cement and additives; and
- miscellaneous materials.

Fuels

Gasoline, diesel, Jet A fuel, natural gas and propane are the fuels that may be employed within the boundaries of the project area. Each of the fuels contains materials classified as hazardous. Gasoline and diesel will be used by vehicles providing transport to and from the project area. Diesel, gasoline, and Jet A fuel will be used for geophysical survey operations. Diesel fuel will also be used in drilling operations and construction equipment, and as a minor component of fracturing fluids. Natural gas produced by the proposed project will be used to power compressor engines and other ancillary facilities. Propane will be utilized for miscellaneous heating purposes.

Gasoline

Gasoline will be used to power vehicles traveling to and from the project area. Gasoline will be purchased from regional vendors and primarily stored and transported in vehicle gas tanks. Some additional gasoline storage may be provided in appropriately designed and labeled one to five gallon containers for supplemental use as vehicle fuel. No large-scale storage of gasoline is anticipated. The hazardous substances expected to be present in gasoline include:

Benzene	n-Hexane	POM
Cumene	Methyl tert-butyl ether	Toluene
Cyclohexane	Naphthalene	Xylenes
Ethylbenzene	PAHs	

No extremely hazardous materials are expected to be present in the gasoline.

Diesel

Diesel fuel will be used to power transport vehicles, geophysical vehicles, drilling rigs and construction equipment. Each well location will have aboveground storage tanks containing diesel fuel during drilling operations. Tanks will be filled by a local fuel supplier. The use, transport and storage of diesel fuel will be conducted in accordance with all relevant local, state and federal rules, regulations and guidelines. The hazardous substances expected to be present in diesel fuel include:

Benzene	POM
Ethylbenzene	Toluene
Naphthalene	Xylenes
PAHs	

No extremely hazardous materials are expected to be present in the diesel fuel.

Jet A Fuel

Jet A fuel will be utilized to power geophysical vehicles. Jet A fuel will be purchased from regional vendors and primarily will be stored and transported in vehicle tanks. Some additional storage may be provided in appropriately designed and labeled containers for supplemental use as fuel. No large-scale storage of Jet A fuel is anticipated. The hazardous substances expected to be present in Jet A fuel include:

Benzene	n-Hexane	POM
Cumene	Methyl tert-butyl ether	Toluene
Cyclohexane	Naphthalene	Xylenes
Ethylbenzene	PAHs	

No extremely hazardous materials are expected to be present in the Jet A fuel.

Natural Gas

Natural gas produced onsite will be burned to provide power for compressor engines and other ancillary facilities. Hazardous materials expected to be present in natural gas include n-

Hexane, PAHs and POM. No extremely hazardous materials are known to exist in the natural gas from the project area.

Propane

Propane will be utilized for miscellaneous heating purposes throughout the project area. The propane will be purchased from regional vendors and transported and stored in appropriate tanks. No large scale storage of propane is anticipated. The only hazardous material expected to be present in propane is propylene. No extremely hazardous materials are known to be present in propane.

Lubricants

Various lubricants, including motor oils, hydraulic oils, transmission oils, compressor lube oils and greases, will be utilized in project equipment and machinery. Lubricants may contain hazardous substances, particularly:

Barium	Lead	PAHs
Cadmium	Manganese	POM
Copper	Nickel	Zinc

No extremely hazardous materials are known to be present in the lubricants required for the proposed project.

The lubricants will be used, stored, transported and disposed of following manufacturer's guidelines and local, state and federal requirements.

Coolant/Antifreeze and Heat Transfer Agents

Various materials will be utilized as coolant/antifreeze and heat transfer agents in association with the project. Ethylene glycol, a hazardous substance, will be used as an engine coolant/antifreeze in vehicles, construction equipment, gas dehydrators and drilling and workover rigs. Additionally, ethylene glycol will be used as a heat transfer fluid during well completion and maintenance operations. No extremely hazardous materials are known to be present in the coolant/antifreeze and heat transfer agents required for the proposed project. Disposal of ethylene glycol will be conducted in accordance with applicable local, state and federal rules and regulations.

Drilling Fluids

Water-based muds (drilling fluids) will be used for drilling each well. Drilling fluid additives consist of clays and other materials that are used in accordance with standard industry practices. Drilling fluid additives that are expected to be utilized in the drilling phase of coalbed methane well installation and their hazardous and extremely hazardous components are provided in Table C-1. Drilling operations will be conducted in compliance with applicable BLM, WOGCC and WDEQ rules and regulations.

Drilling fluid additives will be transported to well locations during drilling operations in appropriate sacks and other containers, in compliance with DOT regulations. Drilling fluids, cuttings and water will be stored in reserve pits. Netting (1 inch mesh) - to protect waterfowl, other birds and bats; pit liners - to protect shallow groundwater aquifers and conserve water;

and perimeter fencing – to protect wildlife will be used as deemed appropriate by the BLM and WOGCC.

Following drilling and completion operations, the reserve pit contents will be evaporated or solidified in place, the pit backfilled and the surface reclaimed. Reserve pit solidification and/or closure procedures will be approved by the BLM, WOGCC and/or WDEQ prior to implementation. Alternatively, reserve pit contents may be removed and disposed of at an appropriate offsite facility in a manner commensurate with applicable local, state and federal regulations.

Fracturing Fluids

Hydraulic fracturing is not expected to be performed on the coalbed methane wells within the project area. However, it is possible that a well will be hydraulically fractured periodically to augment gas flow rates. Fracturing fluids potentially containing hazardous substances that may be used within the project area are listed in Table C-1. No extremely hazardous materials are known to be present in the fracturing fluids required for the proposed project.

Fracturing fluids and additives will be transported to well locations in bulk or in appropriately designed and labeled containers. Transportation of fracturing fluids and additives will be in adherence with DOT rules and regulations.

During fracturing, fluids are pumped under pressure down the well bore and out through perforations in the casing into the formation. The pressurized fluid enters the formation and induces hydraulic fractures. When the pressure is released at the surface, a portion of the fracturing fluids will be forced back into the well bore, up to the surface and into a tank. The fracturing fluids will then be transferred to lined reserve pits and evaporated or transported offsite for reuse or disposal at an authorized facility. Decisions regarding the appropriate disposal of fracturing fluids would be made by the BLM, WOGCC and DEQ on a case-by-case basis.

Cement and Additives

Well completion and abandonment operations include cementing and plugging various segments of the well bore to protect freshwater aquifers and other downhole resources. Materials potentially used for cementing operations include: cement, calcium hydroxide, calcium chloride, pozzolans, sodium bicarbonate, potassium chloride and insulating oil. An unknown quantity of cement and additives, which may contain the hazardous material classes of fine mineral fibers, PAHs and POM, will be transported in bulk to each well site. Small quantities may also be transported and stored onsite in 50 pound sacks. Wells will be cased and cemented as directed and approved by the BLM or WOGCC.

Miscellaneous Materials

Miscellaneous materials will be used during geophysical, construction, drilling, testing, completion, production, maintenance, transportation, abandonment, and reclamation activities. Miscellaneous materials potentially containing hazardous substances that may be used within the project area are listed in Table C-1. Quantities of these miscellaneous materials are unknown. Materials will be transported to the site by service and supply companies and will be used, stored, transported and disposed of following manufacturer's guidelines and local, state and federal requirements.

Industry standard pipeline materials, equipment, techniques and procedures, in conformance with all applicable regulatory requirements, will be employed during construction, testing, operation and maintenance activities to ensure pipeline safety and efficiency.

Small quantities of natural gas may be vented at certain well locations during testing operations. During testing, produced gas will be vented into a flare pit pursuant to the applicable BLM, WOGCC and WDEQ rules and regulations. BLM, WOGCC and WDEQ approval, as appropriate, will be obtained prior to venting operations.

COMBUSTION EMISSIONS

Gasoline and diesel engines, flaring of natural gas and fired production equipment will produce combustion emissions within the project area. The complete oxidation of hydrocarbon fuels yields only carbon dioxide and water as combustion products. However, complete combustion is seldom achieved. Unburned hydrocarbons, particulate matter, carbon monoxide, nitrogen oxides, and possibly, sulfur oxides will be components of the exhaust streams. The formation of ozone from the photolysis of nitrogen oxides will also be expected. A listing of the hazardous and extremely hazardous materials potentially present in combustion emissions is provided in Table C-1.

Unburned hydrocarbons may contain potentially hazardous PAHs, while particulate matter may contain metal based particles from metallic lubricating oil additives and engine wear. Hazardous materials in the particulate matter may therefore include compounds of lead, cadmium, nickel, copper, manganese, barium and/or zinc. Particulate matter emissions and larger unburned hydrocarbons will eventually settle out on the ground surface, whereas gaseous emissions will react with other air constituents as components of the nitrogen, sulfur and carbon cycles.

Nitrogen dioxide, sulfur dioxide, sulfur trioxide and ozone are potential combustion emissions, all classified as extremely hazardous materials. Releases of these or other materials will not exceed allowable thresholds established by the Prevention of Significant Deterioration and WDEQ Air Quality regulations or the National Ambient Air Quality Standards.

MANAGEMENT POLICY AND PROCEDURE

Project operators and their contractors will ensure production, use, storage, transport and disposal of hazardous and extremely hazardous materials associated with the proposed project will be accomplished in strict accordance with applicable existing, or hereafter promulgated, federal, state and local government rules, regulations and guidelines. Project related activities, involving the production, use and/or disposal of hazardous or extremely hazardous materials, will be conducted in such a manner so as to minimize potential environmental impacts.

Project operators will comply with emergency reporting requirements for releases of hazardous materials. Releases of hazardous or extremely hazardous substances in excess of the reportable quantity, as established in 40 CFR Part 117, will be reported as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended. The materials for which such notification must be given are the extremely hazardous substances listed under the Emergency Planning and Community Right to Know Act, Section 302 and the hazardous substances designated under Section 102 of CERCLA, as amended. If a reportable quantity of a hazardous or extremely hazardous substance is

released, prompt notice of the release will be given to the BLM's Authorized Officer and other appropriate local, state and federal agencies.

Additionally, notice of any spill or leakage (i.e. undesirable event), as defined in BLM NTL-3A, will be provided to the Authorized Officer and other such local, state and federal officials as required by law.

Project operators will prepare and implement, as necessary, the following plans and/or policies:

- spill prevention and control countermeasure plans;
- stormwater pollution prevention plans;
- liquid hydrocarbon spill response plans;
- inventories of hazardous chemical categories pursuant to Section 312 of the SARA, as amended; and
- emergency response plans.

Copies of the above will be maintained by the operators, as required by regulation, and will be made available upon request.

Exploration and production activities in the project area will comply with regulations promulgated under the Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation and Liability Act, Clean Water Act, Safe Drinking Water Act, Toxic Substances Control Act, Occupational Safety and Health Act, Clean Air Act, National Environmental Policy Act and Endangered Species Act, as appropriate. In addition, project activities will also comply with applicable state rules and regulations relating to hazardous material handling, storage, transportation, management, disposal, and reporting.

Table C-1. Hazardous and Extremely Hazardous Materials Potentially Utilized or Produced During Construction, Drilling, Production, and Reclamation Operations

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
Production Streams				
Natural gas				0.2 mmcfd
	n-Hexane		110-54-3	
	PAHs[4]		-	
	POM[5]		-	
Produced Water				200 bpd
	Antimony		7440-36-0	
	Arsenic		7440-38-2	
	Barium		7440-39-3	
	Beryllium		7440-41-7	
	Cadmium		7440-43-9	
	Chromium		7440-47-3	
	Copper		7440-50-8	
	Cyanide		-	
	Lead		7439-92-1	
	Mercury		7439-97-6	
	Nickel		7440-02-0	
		Phenols	108-95-2	
	Radium 226		-	
	Selenium		7782-49-2	
	Silver		7440-22-4	
	Sodium		7440-23-5	
	Thallium		7440-28-0	
	Zinc		7440-66-6	
Liquid Hydrocarbons				UNK
	Benzene		71-43-2	
	Ethylbenzene		100-41-4	
	n-Hexane		110-54-3	
	PAHs		-	
	POM		-	
	Toluene		108-88-3	
	Xylenes		1330-20-7	
Fuels				
Gasoline				UNK
	Benzene		71-43-2	
	Cumene		98-82-8	
	Cyclohexane		110-82-7	
	Ethylbenzene		100-41-4	
	n-Hexane		110-54-3	
	Methyl tert-butyl ether		1634-04-4	
	Naphthalene		91-20-3	
	PAHs		-	
	POM		-	
	Toluene		108-88-3	
	Xylenes		1330-20-7	

Table C-1. Continued.

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
Diesel				UNK
	Benzene		71-43-2	
	Cumene		98-82-8	
Diesel – cont.	Ethylbenzene		10041-4	
	Naphthalene		91-20-3	
	PAHs		-	
	POM		-	
	Toluene		108-88-3	
	Xylenes		108-38-3	
Jet A Fuel				UNK
	Benzene		71-43-2	
	Cumene		98-82-8	
	Cyclohexane		110-82-7	
	Ethylbenzene		100-41-4	
	n-Hexane		110-54-3	
	Methyl tert-butyl ether		1634-04-4	
	Naphthalene		91-20-3	
	PAHs		-	
	POM		-	
	Toluene		108-88-3	
	Xylenes		108-38-3	
Natural Gas				UNK
	n-Hexane		110-54-3	
	PAHs		-	
	POM		-	
Propane				UNK
	Propylene		115-07-1	
Lubricants				UNK
	Barium		7440-39-3	
	Cadmium		7440133-9	
	Copper		7440-50-8	
	Lead		7439-92-1	
	Manganese		7439-96-5	
	Nickel		7440-02-0	
	PAHs		-	
	POM		-	
	Zinc		7440-66-6	
Coolant/Antifreeze and Heat Transfer Agents	Ethylene glycol		107-21-1	UNK
Drilling Fluids				
Barite	Barium compounds		-	16,000 lb
	Fine mineral fibers		-	
Bentonite	Fine mineral fibers		-	45,000 lb

Table C-1. Continued.

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
Caustic soda	Sodium hydroxide		1310-73-2	750 lb
Glutaraldehyde	Isopropyl alcohol		67-63-0	20 gal
Lime	Fine mineral fibers		-	3,500 lb
Mica	Fine mineral fibers		-	600 lb
Modified tannin	Ferrous sulfate Fine mineral fibers		7720-78-7 -	250 lb
Phosphate esters	Methanol		67-56-1	100 gal
Polyacrylamides	 PAHs POM	Acrylamide	79-06-1 - -	100 gal
Retarder	Fine mineral fibers		-	400 lb
Fracturing Fluids				
Biocides	Fine mineral fibers PAHs POM		- - -	UNK
Breakers	Copper compounds Ethylene glycol Fine mineral fibers Glycol ethers		- 107-21-1 - -	UNK
Clay stabilizer	Fine mineral fibers Glycol ethers Isopropyl alcohol Methanol PAHs POM		- - 67-63-0 67-56-1 - -	UNK
Crosslinkers	Ammonium chloride Methanol Potassium hydroxide Zirconium nitrate Zirconium sulfate		12125-02-9 67-56-1 1310-58-3 13746-89-9 14644-61-2	UNK
Foaming agent	Glycol ethers		-	UNK
Gelling agent	Benzene Ethylbenzene Methyl tert-butyl ether Napthalene PAHs POM Sodium hydroxide Toluene Xylenes		71-43-2 100-41-4 1634-04-4 91-20-3 - - 1310-73-2 108-88-3 1330-20-7	UNK

Table C-1. Continued.

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
pH buffers	Acetic acid Benzoic acid Fumaric acid Hydrochloric acid Sodium hydroxide		64-19-7 65-85-0 110-17-8 7647-01-0 1310-73-2	UNK
Sands	Fine mineral fibers		-	UNK
Solvents	Glycol ethers		-	UNK
Surfactants	Glycol ethers Isopropyl alcohol Methanol PAHs POM		- 67-63-0 67-56-1 - -	UNK
Cement and Additives				
Anti-foamer	Glycol ethers		-	100 lb
Calcium chloride flake	Fine mineral fibers		-	2,500 lb
Cellophane flake	Fine mineral fibers		-	300 lb
Cements	Aluminum oxide Fine mineral fibers		1344-28-1 -	77,000 lb
Chemical wash	Ammonium hydroxide Glycol ethers		1336-21-6 -	850 gal
Diatomaceous earth	Fine mineral fibers		-	1,000 lb
Extenders	Aluminum oxide Fine mineral fibers		1344-28-1 -	17,500 lb
Fluid loss additive	 Fine mineral fibers Naphthalene	Acrylamide	79-06-1 - 91-20-3	900 lb
Friction reducer	Fine mineral fibers Naphthalene PAHs POM		- 91-20-3 - -	160 lb
Mud flash	Fine mineral fibers		-	250 lb
Retarder	Fine mineral fibers		-	100 lb
Salt	Fine mineral fibers		-	2,570 lb
Silica flour	Fine mineral fibers		-	4,800 lb

Table C-1. Continued.

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
Miscellaneous Materials				
Acids	Acetic anhydride		108-24-7	UNK
	Formic acid		64-18-6	
	Sodium chromate		777-11-3	
		Sulfuric acid	7664-93-9	
Batteries	Cadmium		744043-9	UNK
		Cadmium oxide	1306-19-0	
	Lead		7439-92-1	
	Nickel hydroxide		7440-02-0	
	Potassium hydroxide		1310-58-3	
		Sulfuric acid	7664-93-9	
Biocides		Formaldehyde	50-00-0	UNK
	Isopropyl alcohol		67-63-0	
	Methanol		67-56-1	
Cleaners	Hydrochloric acid		7647-01-0	UNK
Corrosion inhibitors	4,4' Methylene dianiline		101-77-9	UNK
	Acetic acid		64-19-7	
	Ammonium bisulfite		10192-30-0	
	Diethylamine		109-89-7	
	Dodecylbenzenesulfonic acid		27176-87-0	
	Ethylene glycol		107-21-1	
	Isobutyl alcohol		78-83-1	
	Isopropyl alcohol		67-63-0	
	Methanol		67-56-1	
	Naphthalene		91-20-3	
	Sodium nitrite		7632-00-0	
	Toluene		108-88-3	
	Xylenes		1330-20-7	
	Zinc carbonate		3486-35-9	
Emulsion breakers	Acetic acid		64-19-7	UNK
	Acetone		67-64-1	
	Ammonium chloride		12125-02-9	
	Benzoic acid		65-85-0	
	Isopropyl alcohol		67-63-0	
	Methanol		67-56-1	
	Naphthalene		91-20-3	
	Toluene		108-88-3	
	Xylenes		1330-20-7	
	Zinc chloride		7646-85-7	
Explosives, fuses, detonators, and boosters	Benzene		71-43-2	UNK
	Cumene		98-82-8	
	Ethylbenzene		100-41-4	
	Ethylene glycol		107-21-1	
	Lead compounds		7439-92-1	
	Methyl tert-butyl ether		1634-04-0	
	Naphthalene		91-20-3	
		Nitric acid	7697-37-2	
	Nitroglycerine		55-63-0	

Table C-1. Continued.

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
	PAHs		-	
	POM		-	
	Toluene		108-88-3	
	Xylenes		1330-20-7	
Fertilizers	UNK		-	UNK
Herbicides	UNK		-	UNK
Lead-free thread compound	Copper		7440-50-8	25 gal
	Zinc		7440-66-6	
Methanol	Methanol		67-56-1	200 gal
Motor oil	Zinc compounds		-	220 gal
Paints	Barium		7440-39-3	UNK
	n-Butyl alcohol		71-36-3	
	Cobalt		7440-48-4	
	Lead		7439-92-1	
	Manganese		7439-96-5	
	PAHs		-	
	POM		-	
		Sulfuric acid	7664-93-9	
	Toluene		108-88-3	
	Triethylamine		121-44-8	
	Xylenes		1330-20-7	
Paraffin control		Carbon disulfide	75-15-0	UNK
	Ethylbenzene		100-41-4	
	Methanol		67-56-1	
	Toluene		108-88-3	
	Xylenes		1330-20-7	
Photoreceptors	Selenium		7782-49-2	UNK
Pipeline -				
Coating	Aluminum oxide		1334-28-1	UNK
Cupric sulfate solution	Cupric sulfate		7758-98-7	UNK
		Sulfuric acid	7664-93-9	
Diethanolamine	Diethanolamine		111-42-2	UNK
LP Gas	Benzene		71-43-2	UNK
	n-Hexane		110-54-3	
	Propylene		115-07-1	
Molecular sieves	Aluminum oxide		1344-28-1	UNK
Pipeline primer	Naphthalene		91-20-3	UNK
	Toluene		108-88-3	
Potassium	Potassium hydroxide		1310-58-3	UNK

Table C-1. Continued.

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
Rubber resin coatings	Acetone		67-64-1	UNK
	Ethyl acetate		141-78-6	
	Methyl ethyl ketone		78-93-3	
	Toluene		108-88-3	
	Xylene		1330-20-7	
Scale inhibitors	Acetic acid		64-19-7	UNK
	Ethylene diamine tetraacetic acid		60-00-4	
	Ethylene glycol		107-21-1	
	Formaldehyde		50-00-0	
	Hydrochloric acid		7647-01-0	
	Isopropyl alcohol		67-63-1	
	Methanol		67-56-1	
	Nitrilotriacetic acid		139-13-9	
Sealants	1,1,1-trichloroethane		71-55-6	UNK
	n-Hexane		110-54-3	
	PAHs		-	
	POM		-	
Solvents	1,1,1-trichloroethane		71-55-6	UNK
	Acetone		67-64-1	
	t-Butyl alcohol		75-65-0	
	Carbon tetrachloride		56-23-5	
	Isopropyl alcohol		67-63-0	
	Methyl ethyl ketone		108-10-1	
	Methanol		67-56-1	
	PAHs		-	
	POM		-	
	Toluene		108-88-3	
	Xylenes		1330-20-7	
Starting fluid	Ethyl ether		60-29-7	UNK
Surfactants		Ethylene diamine	107-15-3	UNK
	Isopropyl alcohol		67-56-1	
Combustion Emissions				
Combustion Products		Formaldehyde	50-00-0	XXXX
		Nitrogen dioxide	10102-44-0	XXXX
		Ozone	10028-15-6	XXXX
		Sulfur dioxide	7446-09-5	XXXX
		Sulfur trioxide	7446-11-9	XXXX
Unburned Hydrocarbons	Benzene		71-43-2	XXXX
	Ethylbenzene		100-41-4	
	n-Hexane		100-54-3	
	PAHs		-	
	Toluene		108-88-3	
	Xylenes		1330-20-7	
Particulate matter	Barium		7440-39-3	XXXX
	Cadmium		7440-43-9	

Table C-1. Continued.

SOURCE	HAZARDOUS SUBSTANCES[1]	EXTREMELY HAZARDOUS SUBSTANCES[2]	CAS NO.	APPROXIMATE QUANTITIES USED OR PRODUCED PER WELL[3]
	Copper		7440-50-8	
	Fine mineral fibers		-	
	Lead		7439-92-1	
	Manganese		7439-96-5	
	Nickel		7440-02-0	
	POM		-	
	Zinc		7440-66-6	

1 Hazardous Substances include those compounds identified in EPA's List of Hazardous Substances – 40 CFR Part 302 and List of Substances for Accidental Release Prevention – 40 CFR Part 68.
2 Extremely Hazardous Substances include those compounds identified in EPA's List of Extremely Hazardous Substances – 40 CFR Part 355.
3 lb = pounds, gal = gallons, mmcfd = million cubic feet per day, bpd = barrels per day and UNK = unknown
4 PAHs – Polynuclear aromatic hydrocarbons
5 POM – Polycyclic organic matter

APPENDIX D

WILDLIFE AND FISH SPECIES LISTS

APPENDIX D

WILDLIFE AND FISH SPECIES LISTS

Table D-1. Wildlife species observed or that may potentially occur on or near the Atlantic Rim Project Area.

		Data Sources*			
Common Name	**Scientific Name**	**WOS**	**ATLAS**	**WYNDD**	**HWA**
MAMMALS					
Badger	*Taxidea taxus*	y	y		y
Bighorn sheep	*Ovis canadensis*	y			
Beaver	*Castor canadensis*	y	y		
Big-brown bat	*Eptesicus fuscus*		y		
Bison	*Bison bison*	y	y		
Black bear	*Ursus americanus*	y	y		
Black-footed ferret	*Mustela nigripes*		y		
Bobcat	*Felis rufus*	y	y		y
Bushy-tailed wood rat	*Neotoma cinerea*	y	y		
Cliff chipmunk	*Tamias dorsalis*		y		
Coyote	*Canis latrans*	y	y		y
Deer mouse	*Peromyscus maniculatus*	y	y		y
Desert cottontail	*Sylvilagus audubonii*	y	y		y
Dusky shrew	*Sorex monticolus*		y		
Dwarf shrew	*Sorex nanus*		y	y	
Eastern cottontail	*Sciurus carolinensis*	y			
Eastern red bat	*Lasiurus borealis*	y	y		
Eastern fox squirrel	*Sciurus niger*		y		
Elk	*Cervus elaphus*	y	y		y
Feral horse	*Equus caballus*	y			y
Golden-mantled groundsquirrel	*Spermophilus lateralis*	y	y		
Grizzly bear	*Ursus arctos*		y		
Hoary bat	*Lasiurus cinereus*		y	y	
Least chipmunk	*Tamias minimus*	y	y		y
Little brown myotis	*Myotis lucifugus*		y		
Long-eared myotis	*Myotis evotis*		y	y	
Long-tailed vole	*Microtus longicaudus*		y		
Long-tailed weasel	*Mustela frenata*	y	y		y
Marten	*Martes americana*	y	y		
Masked shrew	*Sorex cinereus*	y	y		
Meadow vole	*Microtus pennsylvanicus*	y			
Merriam's shrew	*Sorex merriami*		y		
Mink	*Mustela vison*	y	y		
Montane vole	*Microtus montanus*	y	y		
Moose	*Alces alces shirasi*	y	y		
Mountain (Nuttall's) cottontail	*Sylvilagus nuttallii*	y	y		
Mountain lion	*Felis concolor*	y	y		
Mule deer	*Odocoileus hemionus*	y	y		y
Muskrat	*Ondatra zibethicus*	y	y		y
Northern grasshopper mouse	*Onychomys leucogaster*	y	y		
Northern pocket gopher	*Thomomys talpoides*		y		
Olive-backed pocket mouse	*Perognathus fasciatus*	y	y		

Table D-1. Continued.

Common Name	Scientific Name	Data Sources* WOS	ATLAS	WYNDD	HWA
Ord's kangaroo rat	*Dipodomys ordii*	y	y		y
Pika	*Ochotona princeps*		y		
Porcupine	*Erethizon dorsatum*	y	y		y
Pronghorn antelope	*Antilocapra americana*	y	y		y
Raccoon	*Procyon lotor*	y	y		
Red fox	*Vulpes vulpes*	y	y		
Red squirrel	*Tamiasciurus hudsonicus*	y	y		
Ringtail	*Bassariscus astutus*			y	
Sagebrush vole	*Lemmiscus curtatus*	y	y		
Short-tailed (ermine) weasel	*Mustela erminea*		y		
Silky pocket mouse	*Perognathus flavus*		y		
Silver-haired bat	*Lasionycteris noctivagans*	y	y		
Snowshoe hare	*Lepus americanus*	y	y		
Southern red-backed vole	*Clethrionomys gapperi*	y	y		
Spotted ground squirrel	*Spermophilus tridecemlineatus*		y		
Striped skunk	*Mephitis mephitis*	y	y		
Swift fox	*Vulpes velox*		y		
Thirteen-lined groundsquirrel	*Spermophilus tridecemlineatus*	y	y		
Townsend's big-eared bat	*Corynorhinus towsendii*			y	
Uinta ground squirrel	*Spermophilus armatus*		y		
Water shrew	*Sorex palustris*		y		
Western heather vole	*Phenacomys intermedius*		y		
Western jumping mouse	*Zapus princeps*	y	y		
Western small-footed myotis	*Myotis ciliolabrum*	y	y		
Western spotted skunk	*Spilogale gracilis*			y	
White-tailed deer	*Odocoileus virginianus*	y	y		
White-tailed jackrabbit	*Lepus townsendii*	y	y		y
White-tailed prairie dog	*Cynomys leucurus*	y	y	y	y
Wyoming ground squirrel	*Spermophilus elegans*	y	y		y
Wyoming pocket gopher	*Thomomys clusius*		y	y	
Yellow-bellied marmot	*Marmota flaviventris*	y	y		
BIRDS					
American avocet	*Recurvirostra americana*	y	y		y
American bittern	*Botaurus lentiginosus*	y	y		
American coot	*Fulica americana*	y	y		y
American crow	*Corvus brachyrhynchos*	y	y		y
American dipper	*Cinclus mexicanus*	y	y		
American goldfinch	*Carduelis tristis*	y	y		
American kestrel	*Falco sparverius*	y	y		y
American pipit	*Anthus rubescens*	y	y		
American redstart	*Setophaga ruticilla*	y	y		
American robin	*Turdus migratorius*	y	y		y
American tree sparrow	*Spizella arborea*	y	y		
American white pelican	*Pelecanus erythrorhynchos*	y	y		
American wigeon	*Anas Americana*	y	y		y
Ash-throated flycatcher	*Myiarchus cinerascens*		y		

Table D-1. Continued.

Common Name	Scientific Name	WOS	ATLAS	WYNDD	HWA
		Data Sources*			
Baird's sandpiper	*Calidris bairdii*	y	y		
Baird's sparrow	*Ammodramus bairdii*	y			
Bald eagle	*Haliaeetus luecocephalus*	y	y	y	
Baltimore oriole	*Icterus galbula*	y			
Bank swallow	*Riparia riparia*	y	y		y
Barn swallow	*Hirundo rustica*	y	y		
Barrow's goldeneye	*Bucephala islandica*		y		
Belted kingfisher	*Ceryle alcyon*	y	y		
Bewick's wren	*Thryomanes bewickii*	y	y		
Black rosy-finch	*Leucosticte atrata*		y		
Black tern	*Chlidonias niger*	y	y		
Black-and-white warbler	*Mniotilta varia*		y		
Black-bellied plover	*Pluvialis dominicus*	y	y		
Black-billed cuckoo	*Coccyzus erythropthalmus*		y		
Black-billed magpie	*Pica pica*	y	y		y
Black-capped chickadee	*Parus atricapillus*	y	y		
Black-chinned hummingbird	*Archilochus alexandri*			y	
Black-crowned night heron	*Nycticorax nycticorax*	y	y		
Black-headed grosbeak	*Pheucticus melanocephalus*	y	y		
Black-necked stilt	*Himantopus mexicanus*	y	y		
Black-throated gray warbler	*Dendroica caerulescens*		y	y	
Blue grosbeak	*Guiraca caerulea*		y		
Blue grouse	*Dendragapus obscurus*	y	y		
Blue jay	*Cyanocitta cristata*		y		
Blue-gray gnatcatcher	*Polioptila caerulea*	y	y		
Blue-winged teal	*Anas discors*	y	y		y
Bobolink	*Dolichonyx oryzivorus*	y	y	y	?
Bohemian waxwing	*Bombycilla garrulus*		y		
Bonaparte's gull	*Spizella breweri*	y	y		
Brewer's sparrow	*Euphagus cyanocephalus*	y	y	y	y
Brewer's blackbird	*Selasphorus platycercus*	y	y		
Broad-tailed hummingbird	Selasphorus platycercus	y	y		
Broad-winged hawk	*Buteo platypterus*		y		
Brown creeper	*Certhia americana*	y	y		
Brown thrasher	*Taxostoma rufum*	y	y		
Brown-capped rosy-finch	*Leucosticte australis*		y		
Brown-headed cowbird	*Molothrus ater*	y	y		y
Buff-breasted sandpiper	*Tryngites subruficollis*	y	y		
Bufflehead	*Bucephala albeola*	y	y		y
Burrowing owl	*Athene cunicularia*	y	y	y	y
California gull	*Larus californicus*	y	y		
Canada goose	*Branta canadensis*	y	y		y
Canvasback	*Aythya valisineria*	y	y		
Canyon wren	*Catherpes mexicanus*	y	y		
Cassin's finch	*Carpodacus cassinii*	y	y		
Cattle egret	*Bubulcus ibis*		y		
Cedar waxwing	*Bombycilla cedrorum*		y		
Chestnust-collared longspur	*Calcarius ornatus*	y			

Table D-1. Continued.

Common Name	Scientific Name	Data Sources* WOS	ATLAS	WYNDD	HWA
Chipping sparrow	*Spizella passerina*	y	y		
Cinnamon teal	*Anas cyanoptera*	y	y		y
Clark's nutcracker	*Nucifraga columbiana*	y	y		
Cliff swallow	*Hirundo pyrrhonota*	y	y		
Common goldeneye	*Bucephala clangula*		y		
Common grackle	*Quiscalus quiscula*	y	y		
Common merganser	*Mergus merganser*	y	y		y
Common nighthawk	*Chordeiles minor*	y	y		
Common poorwill	*Phalaenoptilus nuttallii*	y	y		
Common raven	*Corvus corax*	y	y		y
Common snipe	*Gallinago gallinago*	y	y		y
Common tern	*Sterna hirundo*	y			
Common yellowthroat	*Geothylpis trichas*	y	y		
Cooper's hawk	*Accipiter cooperii*	y	y		
Cordilleran fly catcher	*Empidonax occidentalis*	y	y		
Dark-eyed junco	*Junco hyemalis*	y	y		
Double-crested cormorant	*Phalacrocorax auritus*	y	y		
Downy woodpecker	*Picoides pubescens*	y	y		
Dusky flycatcher	*Empidonax oberholseri*	y	y		
Eared grebe	*Podiceps nigricollis*	y	y		
Eastern kingbird	*Tyrannus tyrannus*	y	y		
Eastern screech owl	*Otus asio*	y			
European starling	*Sturnus vulgaris*	y	y		y
Evening grosbeak	*Coccothraustes vespertinus*	y	y		
Ferruginous hawk	*Buteo regalis*	y	y		y
Field sparrow	*Spizella pusilla*	y			
Forster's tern	*Sterna forsteri*	y	y		
Fox sparrow	*Passerella iliaca*	y	y		
Franklin's gull	*Larus pipixcan*	y	y		
Gadwall	*Anas strepera*	y	y		y
Golden eagle	*Aquila chrysaetos*	y	y		y
Golden-crowned kinglet	*Regulus satrapa*	y	y		
Grasshopper sparrow	*Ammodramus savannarum*	y			
Gray catbird	*Dumetella carolinensis*	y	y		
Gray flycatcher	*Empidonax wrightii*	y	y		
Gray jay	*Perisoreus canadensis*	y	y		
Gray-crowned rosy-finch	*Leucosticte tephrocotis*	y	y		
Great-blue heron	*Ardea herodias*	y	y		
Greater yellowlegs	*Tringa melanoleuca*	y	y		
Great horned owl	*Bubo virginianus*	y	y		y
Green heron	*Butorides virescens*	y	y		
Green-tailed towhee	*Pipilo chlorurus*	y	y		
Green-winged teal	*Anas crecca*	y	y		y
Hairy woodpecker	*Picoides villosus*	y	y		
Hammond's flycatcher	*Empidonax hammondii*		y	y	
Horned grebe	*Podiceps auritus*	y			
Hermit thrush	*Catharus guttatus*	y	y		
Herring gull	*Larus argentatus*	y			

Table D-1. Continued.

Common Name	Scientific Name	WOS	ATLAS	WYNDD	HWA
		Data Sources*			
Horned lark	*Eremophila alpestris*	y	y		y
House finch	*Carpodacus mexicanus*	y	y		
House sparrow	*Passer domesticus*		y		
House wren	*Troglodytes aedon*	y	y		
Hudsonian godwit	*Limosa haemastica*	y			
Indigo bunting	*Passerina cyanea*		y		
Killdeer	*Charadrius vociferus*	y	y		y
Lark bunting	*Calamospiza melanocorys*	y	y		
Lark sparrow	*Chondestes grammacus*	y	y		
Lazuli bunting	*Passerina ameoena*		y		
Least flycatcher	*Empidonax minimus*		y		
Least sandpiper	*Calidris minutilla*	y	y		
Lesser scaup	*Aythya affinis*	y	y		y
Lesser yellowlegs	*Tringa flavipes*	y	y		
Lewis' woodpecker	*Melanerpes lewis*	y	y	y	
Lincoln's sparrow	*Melospiza lincolnii*		y		
Loggerhead shrike	*Lanius ludovicianus*	y	y		y
Long-billed curlew	*Numenius americanus*	y	y		
Long-billed dowitcher	*Limnodromus scolopaceus*	y	y		y
Long-eared owl	*Asio otus*	y	y		
Macgillivray's warbler	*Oporornis tolmiei*	y	y		
Mallard	*Anas platyrhynchos*	y	y		y
Marbled godwit	*Limosa fedora*	y	y		
Marsh wren	*Cistothorus palustris*	y	y		
McCown's longspur	*Calcarius mccownii*		y	y	
Merlin	*Falco columbarius*	y	y	y	y
Mountain bluebird	*Sialia currucoides*	y	y		y
Mountain chickadee	*Parus gambeli*	y	y		
Mountain plover	*Charadrius montanus*	y	y	y	y
Mourning dove	*Zenaida macroura*	y	y		y
Northern (Bullock's) oriole	*Icterus bullockii*		y		
Northern flicker	*Colaptes auratus*	y	y		y
Northern goshawk	*Accipiter gentilis*	y	y	y	
Northern harrier	*Circus cyaneus*	y	y		y
Northern mockingbird	*Mimus polyglottos*		y		
Northern pintail	*Anas acuta*	y	y		y
Northern rough-winged swallow	*Stelgidopteryx serripennis*	y	y		
Northern saw-whet owl	Aegolius acadicus		y		
Northern shoveler	*Anas clypeata*	y	y		
Northern shrike	*Lanius excubitor*	y	y		
Northern waterthrush	*Seiurus noveboracensis*		y		
Olive-sided flycatcher	*Contopus borealis*	y	y		
Orange-crowned warbler	*Vermivora celata*	y	y		
Ovenbird	*Seiurus aurocapillus*		y		
Osprey	*Pandion haliaetus*	y			
Pectoral sandpiper	*Calidris melanotos*	y	y		
Peregrine falcon	*Falco peregrinus*	y	y		

Table D-1. Continued.

Common Name	Scientific Name	WOS	ATLAS	WYNDD	HWA
		Data Sources*			
Pied billed grebe	*Podilymbus podiceps*	y	y		
Pine grosbeak	*Pinicola enucleator*		y		
Pine siskin	*Carduelis pinus*	y	y		
Pinyon jay	*Gymnorhinus cyanocephalus*	y	y		
Plain titmouse	*Baeolophus griseus*	y		y	
Prairie falcon	*Falco mexicanus*	y	y		y
Red crossbill	*Loxia curvirostra*	y	y		
Red-breasted merganser	*Mergus serrator*		y		
Red-breasted nuthatch	*Sitta canadensis*	y	y		
Red-eyed vireo	*Vireo olivaceus*		y		
Redhead	*Aythya americana*	y	y		
Red-naped sapsucker	*Sphyrapicus nuchalis*	y	y		
Red-necked grebe	*Podiceps grisegena*	y			
Red-necked phalarope	*Phalaropus lobatus*	y	y		
Red-tailed hawk	*Buteo jamaicensis*	y	y		y
Red-winged blackbird	*Agelaius phoeniceus*	y	y		
Ring-billed gull	*Larus delawarensis*	y	y		
Ring-necked duck	*Aythya collaris*	y	y		y
Ring-necked pheasant	*Phasianus colchicus*	y			
Rock dove	*Columba livia*		y		
Rock wren	*Salpinctes obsoletus*	y	y		
Rose-breasted grosbeak	*Pheucticus ludovicianus*	y			
Rough-legged hawk	*Buteo lagopus*	y	y		
Ruby-crowned kinglet	*Regulus calendula*	y	y		
Ruddy duck	*Oxyura jamaicensis*	y	y		y
Ruddy turnstone	*Arenaria interpres*	y	y		
Rufous hummingbird	*Selasphorus rufus*		y		
Greater sage-grouse	*Centrocercus urophasianus*	y	y		y
Sage sparrow	*Amphispiza belli*	y	y	y	
Sage thrasher	*Oreoscoptes montanus*	y	y		y
Sanderling	*Calidris alba*	y	y		
Sandhill crane	*Grus canadensis*	y	y		
Savannah sparrow	*Passerculus sandwichensis*	y	y		
Say's phoebe	*Sayornis saya*	y	y		
Scott's oriole	*Icterus parisorum*		y	y	
Semipalmated plover	*Charadrius semiplamatus*	y	y		
Semipalmated sandpiper	*Calidris pusilla*	y	y		
Sharp-shinned hawk	*Accipiter striatus*	y	y		
Sharp-tailed grouse	*Tympanuchus phasianellus*	y	y	y	
Short-eared owl	*Asio flammeus*	y	y	y	
Snow bunting	*Plectrophenax nivalis*	y	y		
Snow goose	*Chen caerulescens*	y			
Snowy egret	*Egretta thula*	y	y		
Snowy plover	*Charadrius alexandrinus*	y	y	y	
Sora	*Porzana carolina*	y	y		
Solitary sandpiper	*Tringa solitaria*	y	y		
Solitary vireo	*Vireo solitarius*	y	y		

Table D-1. Continued.

Common Name	Scientific Name	Data Sources* WOS	ATLAS	WYNDD	HWA
Song sparrow	*Melospiza melodia*	y	y		
Spotted sandpiper	*Actitis macularia*	y	y		
Spotted towhee	*Pipilo maculatus*		y		
Steller's jay	*Cyanocitta stelleri*	y	y		
Stilt sandpiper	*Calidris himantopus*	y	y		
Swainson's hawk	*Buteo swainsoni*	y	y		y
Swainson's thrush	*Catharus ustulatus*		y		
Swamp sparrow	*Melospiza georgiana*		y		
Tennessee warbler	*Vermivora peregrina*		y		
Three-toed woodpecker	*Picoides tridactylus*	y	y	y	
Townsend's solitaire	*Myadestes townsendii*	y	y		
Townsend's warbler	*Dendroica townsendii*		y		
Tree swallow	*Tachycineta bicolor*	y	y		
Trumpeter swan	*Cygnus buccinator*	y			
Tundra swan	*Cygnus columbianus*		y		
Turkey	*Meleagris gallopavo*	y			
Turkey vulture	*Cathartes aura*	y	y		y
Veery	*Catharus fuscescens*	y	y		
Vesper sparrow	*Pooecetes gramineus*	y	y		y
Violet-green swallow	*Tachycineta thalassina*	y	y		y
Virginia's warbler	*Vermivora virginiae*	y	y		
Warbling vireo	*Vireo gilvus*	y	y		
Western grebe	*Aechmophorus occidentalis*	y	y		
Western kingbird	*Tyrannus verticalis*	y	y		
Western meadowlark	*Sturnella neglecta*	y	y		y
Western sandpiper	*Calidris mauri*	y	y		
Western scrub-jay	*Apheloma californica*		y	y	
Western tanager	*Piranga ludoviciana*	y	y		
Western wood-peewee	*Cantopus sordidulus*	y	y		
White-breasted nuthatch	*Sitta carolinensis*		y		
White-crowned sparrow	*Zonotrichia leucoophrys*	y	y		
White-faced ibis	*Plegadis chihi*	y	y		y
White-throated swift	*Aeronautes saxatalis*	y	y		
White-winged crossbill	*Loxia leucoptera*		y		
Willet	*Catotrophorus semipalmatus*	y	y		y
Williamson's sapsucker	*Sphyrapicus thyroideus*		y	y	
Willow flycatcher	*Empidonax traillii*		y		
Wilson's phalarope	*Phalaropus tricolor*	y	y	y	y
Wilson's warbler	*Wilsonia pusilla*	y	y		
Wood duck	*Aix sponsa*		y		
Yellow warbler	*Dendroica petechia*	y	y		
Yellow-breasted chat	*Icteria virens*	y	y		
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	y	y		y
Yellow-rumped warbler	*Dendroica coronata*	y	y		
AMPHIBIANS					
Boreal chorus frog	*Pseudacris triseriata maculata*	y	y		

Table D-1. Continued.

Common Name	Scientific Name	Data Sources* WOS	ATLAS	WYNDD	HWA
Boreal toad	*Bufo boreas boreas*		y		
Great Basin spadefoot toad	*Scaphiopus intermontanus*		y		
Northern leopard frog	*Rana pipiens*		y	y	
Plains spadefoot toad	*Scaphiopus bombifrons*	y			
Tiger salamander	*Ambystoma tigrinum*	y	y		
REPTILES					
Eastern short horned lizard	*Phrynosoma douglassi brevirostre*	y	y		y
Great Basin gopher snake	*Pituophis melanoleucas deserticola*				y
Many-lined skink	*Eumeces multivirgatus*		y	y	
Northern sagebrush lizard	*Sceloporus graciosus graciosus*		y		y
Ornate box turtle	*Terrapene ornata ornata*		y		
Prairie lined racer	*Cnemidophorus sexlineatus viridis*	y			
Pale milk snake	*Lampropeltis triangulum multistrata*		y	y	
Prairie rattlesnake	*Crotalus vinidus vinidus*	y	y		y
Wandering garter snake	*Thamnophis elegans vagrans*	y	y		
Western plains garter snake	*Thamnophis radix haydeni*		y		
Western smooth green snake	*Opheodrys vernalis blanchardi*	y	y	y	

*Data Sources
- Atlas of Birds, Mammals, Reptiles and Amphibians in Wyoming (WGFD 1999)
- WGFD Wildlife Observation System (WGFD 2003)
- Wyoming Natural Diversity Database (2003)
- Hayden-Wing Associates Field Surveys 2000-2003

Table D-2. Fish species observed within the ARPA or that may potentially occur downsteam of the Atlantic Rim Project Area.

Common Name	Scientific Name	Game or Non game	Basin[1]	Present in ARPA	Native to ARPA	Data Sources[2] WYNDD	FOW	BLM	MCBMP	WSAM
Bigmouth shiner	*Notropis dorsalis*	Non Game	NP				x			
Black bullhead	*Ameiurus melas*	Game	NP				x			
Black crappie	*Pomoxis maculatus*	Game	NP				x			
Bluegill	*Lepomis macrochirus*	Game	NP				x			
Bluehead sucker	*Catostomus discobolus*	Non Game	LSR	Yes	Yes	x	x	x	x	x
Bonneville cutthroat trout	*Oncorhynchus clarki utah*	Game	NP				x			
Bonytail	*Gila elegans*	Non Game	CR							
Brassy minnow	*Hybognathus hankinsoni*	Non Game	NP				x			
Brook trout	*Salvelinus fontinalis*	Game	NP, LSR, GDB	Yes			x	x	x	x
Brown trout	*Salmo trutta*	Game	NP, LSR				x			
Central stoneroller	*Campostoma anomalum*	Non Game	NP				x			
Channel catfish	*Ictalurus punctatus*	Game	NP, LSR				x			
Colorado pikeminnow	*Ptychocheilus lucius*	Non Game	LSR, CR				x	x		
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	Game	NP, LSR	Yes	Yes	x	x	x	x	x
Common carp	*Cyprinus carpio*	Game	NP, LSR, GDB				x	x		
Common shiner	*Luxilus cornutus*	Non Game	NP				x			
Creek chub	*Semotilus atromaculatus*	Non Game	NP, LSR	Yes			x	x	x	x
Emerald shiner	*Notropis atherinoides*	Non Game	NP				x			
Fathead minnow	*Pimephales promelas*	Non Game	NP				x	x		
Flannelmouth sucker	*Catostomus latipinnis*	Non Game	LSR	Yes	Yes	x	x	x	x	x
Flathead chub	*Platygobio gracilis*	Non Game	NP				x			
Freshwater drum	*Aplodinotus grunniens*	Non Game	NP				x			
Gizzard Shad	*Dorosoma cepedianum*	Non Game	NP				x			
Golden shiner	*Notemigonus crysoleucas*	Non Game	NP				x			
Golden trout	*Oncorhynchus aguabonita*	Game	NP				x			
Grass carp	*Ctenopharygodon idella*	Non Game	NP				x			
Grayling	*Thymallus arcticus*	Game	NP				x			
Green sunfish	*Lepomis cyanellus*	Game	NP			x	x			
Hornyhead chub	*Nocomis biguttatus*	Non Game	NP			x	x			
Humpback chub	*Gila cypha*	Non Game	CR							
Iowa darter	*Etheostoma exile*	Non Game	NP, LSR				x	x	x	x
Johnny darter	*Etheostoma nigrum*	Non Game	NP				x			
Kokanee	*Oncorhynchus nerka*	Game	NP				x			
Lake chub	*Couesius plumbeus*	Non Game	NP				x			
Lake trout	*Salvelinus namaycush*	Game	NP				x			
Largemouth bass	*Micropterus salmoides*	Game	NP				x			
Longnose dace	*Rhinichthys cataractae*	Non Game	NP, LSR	Yes			x		x	x
Longnose sucker	*Catostomus catostomus*	Non Game	NP, LSR				x			
Mottled sculpin	*Cottus bairdi*	Non Game	LSR	Yes	Yes		x	x	x	x
Mountain sucker	*Catostomus platyrhynchus*	Non Game	LSR	Yes	Yes		x	x	x	x
Mountain whitefish	*Prosopium williamsoni*	Game	LSR				x		x	x
Northern Pike	*Esox lucius*	Game	LSR							
Pallid Sturgeon	*Scaphirhynchus albus*	Game	PR						x	
Plains killifish	*Fundulus zebrinus*	Non Game	NP				x			
Plains topminnow	*Fundulus sciadicus*	Non Game	NP				x			
Pumpkin-seed	*Lepomis gibbosus*	Game	NP				x			
Quillback	*Carpiodes cyprinus*	Non Game	NP				x			
Rainbow trout	*Oncorhynchus mykiss*	Game	NP, LSR, GDB	Yes			x		x	x
Razorback sucker	*Xyrauchen texanus*	Non Game	CR							
Red shiner	*Cyprinella lutrensis*	Non Game	NP				x			
Redside shiner	*Richardsonius balteatus*	Non Game	LSR	Yes			x	x	x	x
River carpsucker	*Carpiodes carpio*	Non Game	NP				x			
Roundtail chub	*Gila robusta*	Non Game	LSR	Yes	Yes	x	x	x	x	x
Sand shiner	*Notropis stramineus*	Non Game	NP				x			
Shorthead redhorse	*Moxostoma macrolepidotum*	Non Game	NP				x			
Smallmouth bass	*Micropterus dolomieu*	Game	NP				x			
Snake River cutthroat trout	*Oncorhynchus clarki ssp.*	Game	NP				x			
Speckled dace	*Rhinichthys osculus*	Non Game	LSR	Yes	Yes		x	x	x	x
Splake	*Brook-Lake Trout Hybrid*	Game	NP				x			
Walleye	*Stizostedion vitreum*	Game	NP, LSR							x
White crappie	*Pomoxis annularis*	Game	NP				x	x		
White sucker	*Catostomus commersoni*	Non Game	NP, LSR	Yes			x	x		
Yellow perch	*Perca flavescens*	Game	NP				x			
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*	Game	LSR				x			

[1]Basins
NP = North Platte River Basin
LSR = Little Snake River Basin
GDB = Great Divide Basin
CR = These species are downstream residents of the Colorado River Basin
PR = These species are downstream residents of the Platte River Basin
[2]Data Sources
- Wyoming Natural Diversity Database (WNDD 2003)
- Fishes of Wyoming (FOW) (Baxter and Stone 1995)
- Muddy Creek Basin Management Plan (MCBMP)(WGFD 1998)
- Warmwater Stream Assessment Manual (WSAM)(WGFD 2004)
- Mark Fowden, WGFD, personal communication (WGFD)
- Bureau of Land Management (BLM) (USDI-BLM 2001)

APPENDIX E:

WILDLIFE MONITORING AND PROTECTION PLAN

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WILDLIFE MONITORING AND PROTECTION PLAN
ATLANTIC RIM NATURAL GAS EIS

U.S. Bureau of Land Management
Rawlins Field Office
Rawlins, Wyoming

November 2005

APPENDIX E – WILDLIFE MONITORING AND PROTECTION PLAN

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APPENDIX E – WILDLIFE MONITORING AND PROTECTION PLAN

1.0 INTRODUCTION

This wildlife monitoring/protection plan was prepared in conjunction with the environmental impact statement (EIS) for the Atlantic Rim Natural Gas Project (ARNG). The goal of the plan is to avoid and/or minimize adverse impacts to wildlife present on project-affected areas by monitoring wildlife population trends on the ARNG during the course of project development and operations and by developing appropriate mitigation actions. Implementation of the plan will allow land managers and project personnel opportunities to achieve and maintain desired levels of wildlife productivity and populations on the ARNG (e.g., at pre-project levels) by minimizing and/or avoiding potential adverse impacts to wildlife species. In addition, the implementation of this plan will facilitate the maintenance of a diverse assemblage of wildlife populations on the ARNG simultaneously with development of natural gas reserves.

Proposed inventory, monitoring, and protection measures will be implemented under each potential development scenario. Implementation of the plan will begin in 2006, and is estimated to continue for the life of the EIS; however, the plan may be terminated at the end of any year when there is sufficient evidence that wildlife populations and productivity in the ARNG have been successfully protected. The plan will receive a major review for effectiveness every 5 to 6 years or as determined by the Review Team.

2.0 IMPLEMENTATION PROTOCOL

This section provides preliminary wildlife inventory, monitoring, and protection protocol. A summary of primary protocol components is provided in Table 1. Standard protocol for Application for Permit to Drill (APD) and right-of-way (ROW) application field reviews are provided in Table 2. Alternative protocols likely will be developed in the future in response to specific needs identified in annual reports (Section 2.1.1). Methods are provided for each wildlife species/category, and additional species/categories may be added based on needs identified in annual reports. The wildlife species/categories for which specific inventory, monitoring, and protection procedures will be applied were developed based on management agency (Bureau of Land Management [BLM], U.S. Fish and Wildlife Service [USFWS], Wyoming Game and Fish Department [WGFD]) and individual concerns identified during the preparation of the EIS.

Considerable efforts will be required by agency and operator personnel for plan implementation. Many of the annually proposed agency data collection activities are consistent with current agency requirements. Additionally, during annual planning (Section 2.1.2) and throughout project implementation, all efforts will be made to accommodate agency personnel schedules and responsibilities, and further agency cost-sharing approaches will be considered such that public demands and statutory directives are achieved.

2.1 ANNUAL REPORTS AND MEETINGS

2.1.1 Reports

During project development, operators will provide an updated inventory and description of all existing project features (i.e., location, size, and associated level of human activity at each feature), as well as those tentatively proposed for development during the next 12 months in a format that is

compatible with a Geographic Information System (GIS). This inventory will be submitted to the BLM by operators no later than October 15 of each calendar year. These data will be coupled with annual wildlife inventory, monitoring, and protection data obtained for the previous year and included in annual reports. Annual reports will be prepared by the operators' third party contractor with BLM oversight. Annual wildlife inventory, monitoring and protection data gathered in conjunction with the project will be provided to the BLM by October 15 of each calendar year.

Annual reports will summarize annual wildlife inventory and monitoring results, note any trends across years, identify and assess protection measures implemented during past years, specify monitoring and protection measures proposed for the upcoming year, recommend modifications to the existing wildlife monitoring/protection plan based on the successes and/or failures of past years and identify additional species/categories to be monitored. Where possible, the data presented in reports will be used to identify potential correlations between development and wildlife productivity and/or abundance, as well as, sources of potential disturbance to wildlife. A GIS will be used for information storage, retrieval, planning, and annual GIS data updates will be conducted. Raw data collected each year also will be provided to other management agencies, at the request of the agencies.

Annual reports will be completed in draft and submitted to the BLM, operators and other interested parties by November 15 of each year. A final annual report will be issued to all potentially affected individuals and groups by early February of each year. Additional reports may be prepared in any year, as necessary, to comply with other relevant wildlife laws, rules, and regulations.

2.1.2 Meetings

A one day meeting will be organized by the BLM and held in December (or as determined by the Review Team) of each year to discuss and modify, as necessary, proposed wildlife inventory, monitoring and protection protocol for the subsequent year. Decisions regarding annual operator-specific financing and personnel requirements will be made at these meetings. A protocol regarding how to accommodate previously unidentified development sites will also be determined during the annual meeting. Final decisions will be made by the BLM based on the input of all affected parties.

Additional meetings may be held in any given year to inform and update cooperators on the findings of additional reports, as necessary.

2.2 ANNUAL INVENTORY AND MONITORING

Inventory and monitoring protocols will be as identified below for each wildlife species/category. These protocols will be unchanged across development alternatives, except as authorized by the BLM or specified in this plan. Additional wildlife species/categories and associated surveys may be added or wildlife species/categories and surveys may be omitted in future years, pending results presented in the coordinated review of annual reports. Opportunistic wildlife observations may be made throughout the year by agency and operator personnel present in the project area.

The frequency of inventory and monitoring will be dependent upon the level of development in the project area. In general, inventory and monitoring frequency will increase with increased levels of development. Inventory and monitoring results may lead to further, currently unidentifiable, scientific studies specifically designed to determine cause and effect. The review team and/or BLM will identify the level of effort required by this wildlife plan subject to the standard listed below. Site- and species-specific surveys will be conducted in association with APD and ROW application field reviews.

2.2.1 Threatened, Endangered, Candidate, and Other Species of Concern

The level of inventory/monitoring required for threatened, endangered, candidate, and other species of concern (TEC&SC) will be commensurate with established protocols for the potentially affected species. All surveys will be conducted in coordination with the BLM. Methodologies and results of these surveys will be included in annual reports and provided in separate supplemental reports. A preliminary list of TEC&SC species proposed for management and known from or potentially occurring in the vicinity of the project area is shown Chapter 3. As TEC&SC species are added to or withdrawn from USFWS, BLM, and/or WGFD lists, appropriate modifications will be incorporated to this plan and specified in annual reports.

TEC&SC data collected during surveys and described below will be provided only as necessary to those requiring the data for specific management and/or project development needs. Site- and species-specific TEC&SC surveys will be conducted as necessary in association with all APD and ROW application field reviews.

2.2.1.1 Black-footed Ferret

The USFWS, in coordination with the WGFD, has developed a list of habitat blocks that are not likely to be inhabited by black-footed ferrets (block cleared). In these areas, take of individual ferrets and effects to a wild population are not an issue and surveys for ferrets are no longer recommended. Although ferret surveys are not required in these areas, the area may still maintain value for the survival and recovery of the species in the future. Additionally, areas remain that require ferret surveys (non-block cleared) in potential habitat. A portion of the project area coincides with the Dad complex, which is a non-block cleared area, requiring ferret surveys in areas that would likely result in the take of a ferret during project implementation.

BLM biologists will determine the presence/absence of prairie dog colonies at each proposed development site during APD and ROW application field reviews. Prairie dog colonies in the project area will be mapped and burrow densities determined by a BLM-approved operator-financed biologist, as necessary and in association with proposed development plans. Colonies that meet USFWS criteria as potential black-footed ferret habitat (USFWS 1989), in non-block cleared areas, will be surveyed for black-footed ferrets by an USFWS-certified operator-financed surveyor prior to BLM authorizing disturbance of these colonies. Surveys will be conducted as deemed necessary, during consultation with the BLM and/or USFWS. Black-footed ferret surveys will be conducted in accordance with USFWS guidelines (USFWS 1989) and approved by BLM and USFWS.

2.2.1.2 Bald Eagle, Peregrine Falcon, and Ferruginous Hawk

Inventory and monitoring protocol for bald eagle, peregrine falcon, and ferruginous hawk will be as described for raptors (Section 2.2.1).

2.2.1.3 Greater Sage-Grouse & Columbian Sharp-Tailed Grouse

Greater sage-grouse/Columbian sharp-tailed grouse lek inventories will be conducted by the BLM and Wyoming Game & Fish Department on the project area and a two mile/one mile buffer to determine lek locations every 5 years, or as deemed appropriate by the BLM. Surveys may be conducted aerially, with operator-provided financial assistance for aircraft rental, or on the ground, in order to determine lek locations.

Selected leks within two miles/one mile of existing and proposed disturbance areas will be monitored annually to determine lek attendance by the BLM or a BLM-approved operator-financed biologist, between March 1 and May 15, such that all leks on these areas are monitored at least once every 3 years. Monitoring efforts will be implemented at all leks present on affected sections, two mile buffers, and selected undeveloped comparison areas. The BLM will direct lek monitoring efforts such that efforts are made to have the same individuals monitor the same leks within and across years. Data collected during these surveys will be provided on a standardized form. Standard site- and species-specific grouse lek surveys will be conducted as necessary in association with all APD and ROW application field reviews.

2.2.1.4 Mountain Plover

Mountain plover habitat will be mapped within proposed disturbance areas (as identified in annual reports) prior to development of these areas by the BLM or a BLM-approved operator-financed biologist. In addition, these areas will be surveyed annually by the BLM or a BLM-approved operator-financed biologist to detect the presence of plovers. Surveys will be conducted during the period of May 1 through June 30. Data collected during these surveys will be provided on mountain plover route survey forms. Standard site-specific habitat surveys will be conducted as necessary in association with all APD and ROW application field reviews.

2.2.1.5 Western Burrowing Owl

Prairie dog colonies and other suitable burrowing owl nesting areas on and within 0.75 miles of existing and proposed disturbance areas will be searched for western burrowing owls by the BLM or a during June through August to determine the presence or absence of nesting owls. If burrowing owls are found, attempts will be made to determine reproductive success. Standard site-specific surveys will be conducted in association with all APD and ROW application field reviews.

2.2.1.6 Other TEC&SC Species

Surveys for other TEC&SC species will be conducted by the BLM or a BLM-approved operator-financed biologist in areas of potential habitat within 0.5 mile of proposed disturbance sites prior to disturbance. These surveys may be implemented in conjunction with surveys for other species or as components of APD and/or ROW application processes. If any TEC&SC species are observed, the observations will be noted on appropriate data forms and efforts will be made to determine their activities (e.g., breeding, nesting, foraging, hunting, etc.). If any management agency identifies a potential for concern regarding any of these species, additional inventory and monitoring and mitigation may be implemented as specified in annual reports.

2.2.2 Raptors

Raptor inventories will be conducted by the BLM, at least every five years or prior to development of proposed disturbance areas (as identified in annual reports), to determine the location of raptor nests. Raptor nest monitoring will be conducted by the BLM or a BLM approved operator-financed biologist, annually, at known nest locations, between April and July, in order to ascertain nest activity status. These surveys may be implemented aerially, via helicopter, or from the ground. Operators may provide financial assistance for aircraft rental.

Nest productivity monitoring will be conducted by the BLM at active nests, for selected species, to determine nesting success. Monitoring generally will be conducted from the ground, and attempts will be made to determine the cause of any documented nest failure. Operators may provide

financial assistance for aircraft rental, as necessary. Site- and species-specific raptor nest inventories will be conducted as necessary in association with all APD and ROW application field reviews.

All raptor nest/productivity surveys will be conducted using procedures that minimize potential adverse effects to nesting raptors. Specific survey measures for reducing detrimental effects are listed in Grier and Fyfe (1987) and Call (1978) and include the following.

- Nest visits will be delayed for as long as possible in the nesting season.
- Nests will be approached cautiously, and their status (i.e., number of nestlings/fledglings) will be determined from a distance with binoculars or a spotting scope.
- Nests will be approached tangentially and in an obvious manner to avoid startling adults.
- Nests will not be visited during adverse weather conditions (e.g., extreme cold, precipitation events, windy periods, and hottest part of the day).
- Visits will be kept as brief as possible.
- All inventories will be coordinated by the BLM.
- The number of nest visits in any year will be kept to a minimum.
- All raptor nest location data will be considered confidential.

2.2.3 Big Game Crucial Winter Range

Data on big game use of crucial winter ranges on the project area and an adjacent one mile buffer will be requested annually by the BLM from the WGFD, as deemed necessary by the BLM. This information will be used to assess the effectiveness of protection measures implemented for the project.

2.2.4 Other Inventory and Monitoring Measures

Additional inventory and monitoring measures may be applied for other species as specified in annual reports. Surveys will be conducted in adherence with protocol to be established by the BLM, other agencies and operators. Operators may provide financial assistance for these investigations.

2.2.5 General Wildlife

BLM staff will be responsible for maintaining records of selected wildlife species observed during the course of their activities on the project area. Operator personnel may also provide data on wildlife observations. The information provided will include observations of wildlife species, their numbers, location, activity, and other pertinent data as applicable and identified on the General Wildlife Observation Data Sheet. Where operators are uncertain of the USGS coordinates for an observation, a general description of the location may be provided and in instances where species or sex information is questionable, operators will identify the observation as such.

2.3 PROTECTION MEASURES

The wildlife protection measures proposed herein have been developed from past measures identified for oil and gas developments in Wyoming. Additional measures may be included and/or existing measures may be modified in any given year as allowable and as deemed appropriate by BLM in consultation with other agencies, operators and interested parties. These measures will be specified in annual reports. Protection measures will be implemented by operators with assistance from and/or in consultation with the BLM. In addition, these measures may be modified on a

site-specific basis as deemed appropriate by the BLM after completion of APD and ROW application field reviews.

The principal protection measure for most wildlife will be species- and project-specific measures as well as general wildlife protection measures (Section 2.3.4). Implementation of these measures may benefit other wildlife species found on and adjacent to the project area. Sensitive/crucial habitats should be avoided where possible.

2.3.1 TEC&SC

USFWS and WGFD consultation and coordination will be conducted for all protection activities relating to TEC&SC species and their habitats. Where possible, these actions will be specified in advance in the annual reports.

2.3.1.1 Black-footed Ferret

In general, all prairie dog colonies on the project area will be avoided, where practical. If prairie dog colonies, in non-block cleared areas, of sufficient size and burrow density for black-footed ferrets are scheduled to be disturbed, black-footed ferret surveys of these colonies will be conducted pursuant to BLM and/or USFWS decisions made during informal consultations. Survey protocol will adhere to USFWS guidelines as established in USFWS (1989) and will be conducted by a USFWS-qualified biologist a maximum of one year in advance of the proposed disturbance. Reports identifying survey methods and results will be prepared and submitted to the USFWS and BLM in accordance with Section 7 of the *Endangered Species Act of 1973*, as amended, and the Interagency Cooperation Regulations. Surveys will be financed by the operators.

If black-footed ferrets are found on the project area, the USFWS will be notified immediately and formal consultations will be initiated to develop strategies that ensure no adverse effects to the species. Before ground-disturbing activities are initiated in black-footed ferret habitat, authorizations to proceed must be received from the BLM, in consultation with the USFWS.

2.3.1.2 Bald Eagle, Peregrine Falcon, and Ferruginous Hawk

Protection protocol will be as described for raptors (see Section 2.3.1). Additional measures will be applied on a species- or site-specific basis, as deemed appropriate by the BLM and/or USFWS, and specified in annual reports.

2.3.1.3 Greater Sage-Grouse & Columbian Sharp-Tailed Grouse

Surface disturbance or occupancy will be prohibited with 0.25 miles of the perimeter of occupied leks; Human activity would be avoided between 6:00 p.m. and 9:00 a.m. from March 1 to May 20 within 0.25 miles of the perimeter of occupied leks; Surface disturbance and other actions that create permanent and high-profile structures such as buildings, storage tanks and overhead power lines, will not be constructed within 0.25 to1.0 mile of the perimeter of leks, as determined on a case-by-case basis; Surface disturbing and disruptive activities will not be allowed within two miles of an occupied greater sage-grouse lek or in nesting and early brood-rearing habitat associated with individual leks (when identified and delineated), from March 1 to July 15; Surface disturbing and disruptive activities will not be allowed within one mile of an occupied Columbian sharp-tailed grouse lek or in nesting and early brood-rearing habitat associated with individual leks (when identified and delineated), from March 1 to July 15; Surface disturbing and disruptive activities will not be allowed between November 15 and March 14 in delineated winter concentration areas; and, in order to

minimize noise disturbances to strutting or dancing grouse, compressor stations and generators will be muffled with hospital style mufflers. Other techniques and/or equipment can be utilized, when it is demonstrated that they result in similar or increased noise reduction. Additional noise reduction techniques may be required if research shows that current techniques are not adequate.

2.3.1.4 Mountain Plover

Mountain plover habitat will be avoided where practical. Where these habitats will be disturbed, reclamation will utilize procedures designed to reestablish suitable plover habitat. The primary protection measure for mountain plover on the project area will be avoidance plover habitat during the breeding season. All surface-disturbing activities will be restricted from April 10 to July 10 in mountain plover habitat. Additional protection measures, as shown below, may be implemented in identified mountain plover occupied habitat (i.e., areas where broods and/or adults have been observed in the current year or documented in at least 2 of the past 3 years). Surface disturbance would occur outside identified occupied habitat for mountain plovers where feasible.

- Within ½ mile of the identified mountain plover occupied habitat area; speed limits would be posted at 25 mph on resource roads and 35 mph on local roads during the brood rearing period (June 1 - July 10).
- The access road would be realigned to avoid the identified mountain plover occupied habitat area.
- To protect mountain plover in occupied habitat, traffic would be minimized from June 1 - July 10 by car-pooling and organizing work activities to minimize trips on roads through the mountain plover occupied habitat area.
- To protect mountain plover in occupied habitat, fences, storage tanks, and other elevated structures would be either constructed as low as possible and/or would incorporate perch-inhibitors into their design.
- To minimize destruction of nests and disturbance to breeding mountain plovers, no ground-disturbing activities would occur from April 10 - July 10 unless surveys consistent with the Plover Guidelines or other FWS approved method find that no plovers are nesting in the area.
- A plugged and abandoned well within ½ mile of the identified mountain plover occupied habitat area would be identified with a marker 4 feet tall with a perch inhibitor on the top of the marker.

2.3.1.5 Western Burrowing Owl

Protection protocol will be as described for raptors (Section 2.3.1) as well as avoidance of prairie dog colonies, where practical (Section 2.3.2.1).

2.3.1.6 Other TEC&SC Species

If crucial features for any TEC&SC species are found during surveys of areas within 0.5 miles of proposed disturbance sites, avoidance of these features will be accomplished in consultation and coordination with the BLM, USFWS, and WGFD. Construction activities in these areas will be curtailed until there is concurrence between BLM, USFWS, and WGFD on what activities can be authorized. Activities will, in most cases, be delayed until such time that no adverse effects will occur.

It is assumed that the protocol specified in Section 2.3.4 for general wildlife will likely benefit TEC&SC species as well. If any management agency identifies a potential for impacts to any TEC&SC species, additional measures may be implemented as specified in annual reports.

2.3.2 Raptors

The primary protection measure for raptor species on the project area will be avoidance of nest locations during the breeding season. All surface-disturbing activities will be restricted from February 1 through September 15 within a 0.75 to 1.0 mile radius of raptor nests, depending upon species. In addition, well locations, roads, ancillary facilities, and other surface structures requiring a repeated human presence will not be constructed within 825 feet of raptor nests, except ferruginous hawk, where the restriction will be 1,200 feet (restrictions will generally exclude surface disturbance).

Operators will notify the BLM immediately if raptors are found nesting on or within 1,200 feet of project facilities, and operators will assist the BLM as necessary in erecting artificial nesting structures (ANSs), as appropriate. The use of ANSs will be considered as a last resort for raptor protection. If nest manipulation or a situation requiring a "taking" of a raptor nest becomes necessary, a special permit will be obtained from the Denver USFWS Office, Permit Section, and will be initiated with sufficient lead time to allow for development of mitigation. Required corresponding permits will be obtained from the WGFD in Cheyenne. Consultation and coordination with the USFWS and WGFD will be conducted for all protection activities relating to raptors.

If it is found that project activities could potentially affect raptor nesting on or adjacent to the project area, as determined from decreased raptor productivity or nesting, or documented nest abandonment or failure, ANSs may be constructed at a rate of up to two ANSs for one impacted nest. Existing degraded raptor nests may be upgraded or reinforced to minimize potential impacts. ANSs will be located within the nesting territory of potentially affected raptor pairs, outside of the line-of-sight or nest buffer of actively nesting pairs, where possible. Operators will be responsible for the annual maintenance of ANSs throughout the LOP. Annual ANS maintenance activities will be completed after August 15 and prior to October 15 each year, as necessary. All ANSs on public lands will become the property of the BLM upon completion of the project. Pertinent data regarding ANSs or nests proposed for upgrading will be identified in annual reports.

In cases where existing project features are located within the nest buffers of active raptor nests, no prolonged maintenance activities will be allowed during critical periods. The exact dates of exclusion will be determined by the BLM and will likely vary between nests and from year to year, depending on the species present and variations in weather, nesting chronology, and other factors.

Any power line construction will follow the recommendations of the Avian Power Line Interaction Committee (APLIC) (1994, 1996) and Olendorff et al. (1981) to avoid collisions and/or electrocution of raptors.

2.3.3 Big Game Species

No construction activities or prolonged maintenance actions will be conducted within big game crucial winter range during the crucial winter periods of November 15 - April 30. If right-of-way fencing is required, it will be kept to a minimum, and the fences will meet BLM/WGFD approval for facilitating wildlife movement. Wildlife-proof fencing will be used only to enclose areas that are potentially hazardous to wildlife species, or reclaimed areas where it is determined that wildlife species are impeding successful vegetation establishment. Snow fences, if used, will be limited to

segments of 0.25 miles or less. Project personnel will also be advised to minimize stopping and exiting their vehicles in big game winter habitat during crucial winter periods. In addition, escape openings will be provided along roads in big game crucial winter ranges, as designated by the BLM, to facilitate exit of big game animals from snowplowed roads. Additional habitat protection/improvement measures may also be applied in any given year as directed by the BLM, in consultation with operators and other agencies, and specified in annual reports.

2.3.4 General Wildlife

Unless otherwise indicated, the following protection measures will be applied for all wildlife species. Additional measures primarily designed to minimize impacts to other resources (e.g., vegetation and surface water resources, including wetlands, steep slopes, etc.) are identified in the EIS in Chapter 4.0, and these measures may provide additional protection for wildlife. Additional actions may be applied in any given year to further minimize potential impacts to wildlife. These actions will be specified in annual reports.

All roads on and adjacent to the project area that are required for the proposed project will be appropriately constructed, improved, maintained, and signed to minimize potential wildlife/vehicle collisions and facilitate wildlife (most notably big game) movement through the project area. Appropriate speed limits will be adhered to on all project roads, and operators will advise employees and contractors regarding these speed limits. Some existing roads on the project area and surrounding transportation planning area may be reclaimed if they become redundant, or closed (gated and locked, year-round or seasonally) to deny unnecessary access.

To protect important habitat in portions of the project area (i.e., ephemeral draws dominated by basin big sagebrush) areas with sagebrush greater than three feet tall will be avoided where possible.

Additional non-species-specific wildlife mitigations include the following.

- Reserve, work-over, and flare pits and other locations potentially hazardous to wildlife will be adequately protected by netting and/or fencing as directed by the BLM to prohibit wildlife access.
- If dead or injured raptors, big game, migratory birds, or unusual wildlife are observed on the project area, operator personnel will contact the appropriate BLM and WGFD offices. Under no circumstances will dead or injured wildlife be approached or handled by operator personnel.
- Employee and contractor education will be conducted regarding wildlife laws. If violations are discovered on the project area, operators will immediately notify the appropriate agency. If the violation is committed by an employee or contractor, said employee or contractor will be disciplined and may be dismissed by the operator and/or prosecuted by the WGFD and/or USFWS.
- Operators will implement policies designed to control off-site activities of operational personnel and littering, and will notify all employees (contract and company) that conviction of a violation can result in disciplinary action, including dismissal.

Additional project- and site-specific mitigation measures may be added in future years, as specified in annual reports.

3.0 LITERATURE CITED

Avian Power Line Interaction Committee. 1994. Mitigating bird collisions with power lines: The state of the art in 1994. Edison Electric Institute, Washington, D.C. 78 pp. + append.

____.1996. Suggested practices for raptor protection on power lines: The state of the art in 1996. Edison Electric Institute/Raptor Research Foundation, Washington, D.C. 125 pp. + append.

Baxter, G.T., and M.D. Stone. 1980. Amphibians and reptiles of Wyoming. Wyoming Game and Fish Department, Bulletin No. 16. 137 pp.

Call, M.W. 1978. Nesting habitats and surveying techniques for common western raptors. U.S. Department of the Interior, Bureau of Land Management, Technical Note No. 316. 115 pp.

Dorn, J.L., and R.D. Dorn. 1990. Wyoming birds. Mountain West Publishing, Cheyenne, Wyoming. 138 pp.

Grier, J.W., and R.W. Fyfe. 1987. Preventing research and management disturbance. Pages 173-182 *In* B.A.G. Pendleton, B.A. Milsap, K.W. Cline, and D.M. Bird, editors. Raptor management techniques. Institute of Wildlife Research, National Wildlife Federation, Scientific and Technical Series No. 10. 420 pp.

Olendorff, R.R., A.D. Miller, and R.M. Lehman. 1981. Suggested practices for raptor protection on power lines: The state of the art in 1981.

Raptor Research Report No. 4, Raptor Research Foundation, Inc., University of Minnesota, St. Paul. 111 pp.

U.S. Fish and Wildlife Service. 1989. Black-footed ferret survey guidelines for compliance with the *Endangered Species Act*. U.S. Fish and Wildlife Service, Denver, Colorado, and Albuquerque, New Mexico (April 1989). 10 pp. + append.

Wyoming Game and Fish Department. 1992. Wyoming bird and mammal atlas. 170 pp.

____. 1996. Wyoming observation system records. Wyoming Game and Fish Department, Biological Services, Cheyenne, Wyoming.

____. 1997. Atlas of birds, mammals, reptiles and amphibians in Wyoming. Wyoming Game and Fish Department, Wildlife Division, Biological Services Station, Nongame Program, Lander, Wyoming. 192 pp.

Wyoming Natural Diversity Database. 1995. Wyoming vertebrate species of concern list. Compiled by C. Garber for the Nature Conservancy, Wyoming Natural Diversity Database. 21 pp. + append.

Table 1 Summary of General Wildlife Reporting, Inventory, and Monitoring

ACTION	DATES	RESPONSIBLE ENTITY
Annual tentative plan of development	By October 15, annually	Operator
Annual inventory, monitoring and protection data	By October 15, annually	
Annual reports	Annually: Draft – early November Final – early January	Operator
Annual meeting	December and as necessary	BLM with participation by other agencies and operators
INVENTORY/ MONITORING		
Raptor nest inventory	At least every five years, prior to development	BLM or BLM approved operator financed biologist with operator provided financial assistance for aircraft rental, as necessary
Raptor monitoring	Annually from April to July	BLM or BLM approved operator financed biologist with operator provided financial assistance for aircraft rental, as necessary
Greater sage-grouse & Columbian sharp-tailed grouse lek inventory	At least every five years	BLM or BLM approved operator financed biologist with operator provided financial assistance for aircraft rental, as necessary
Greater sage-grouse & Columbian sharp-tailed grouse lek monitoring	Annually from March to mid-May	BLM or BLM approved operator financed biologist
Big game crucial winter range use/monitoring	As available	BLM will request data from WGFD
Mountain Plover surveys	Annually from May to June	BLM or BLM approved operator financed biologist

Table 2 Summary of General APD/ROW Application Stage Survey/Protection Measures

PROTECTION MEASURE	DATES	RESPONSIBLE ENTITY
Raptor nest survey/inventory within 0.75 to 1.0 miles of proposed disturbance	Yearlong	BLM, operator
Raptor nest season avoidance within 0.75 to 1.0 miles	February 1 to September 15	BLM, operator
Raptor nest avoidance with 825 feet (1200 feet for ferruginous hawk nests)	Yearlong	BLM, operator
TEC&SC surveys	Yearlong, as necessary	BLM, operator
TEC&SC avoidance	Yearlong, as necessary	BLM, operator
Prairie dog colony mapping	Yearlong, as necessary	BLM, operator
Prairie dog colony avoidance	Yearlong, where practical	BLM, operator
Black-footed ferret surveys	As appropriate in accordance with USFWS guidelines	Operator financed USFWS-approved biologist
Mountain Plover habitat surveys	Yearlong	BLM, operator
Mountain plover nest/brood avoidance	April 10 to July 10	BLM, operator
Greater sage-grouse lek/nesting habitat avoidance within 2.0 miles of proposed disturbance; Columbian sharp-tailed grouse lek/nesting habitat avoidance within 1.0 mile of proposed disturbance	March 1 to June 30	BLM, operator
Greater sage-grouse and Columbian sharp-tailed grouse lek avoidance within 0.25 miles of proposed disturbance	Yearlong	BLM, operator
Big game crucial winter range avoidance	November 15 to April 30	BLM, operator
General wildlife avoidance/protection	As necessary	BLM, other agencies, operator

APPENDIX G

BIOLOGICAL ASSESSMENT OF THREATENED, ENDANGERED, PROPOSED, AND CANDIDATE SPECIES FOR THE ATLANTIC RIM NATURAL GAS PROJECT

Biological Assessment
of
Threatened, Endangered, Proposed, and Candidate Species
for the
Atlantic Rim Natural Gas Project

Prepared by

U.S. Department of the Interior
Bureau of Land Management
Rawlins Field Office
Rawlins, Wyoming

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Laramie, Wyoming

September 2005

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APPENDIX G – BIOLOGICAL ASSESSMENT

1.0 Project Description

This Biological Assessment (BA) discusses the potential effects of the proposed Atlantic Rim Natural Gas Project on threatened, endangered, and proposed species pursuant to the Endangered Species Act (ESA) of 1973. Candidate species for listing under the ESA are also discussed. This BA also presents recommendations to assure that the construction and subsequent operation of the proposed project will neither jeopardize the continued existence of those species nor result in the destruction or adverse modification of their critical habitats. Analysis of effects of this proposed project on threatened, endangered, and proposed species complies with the provisions of the ESA. The Bureau of Land Management (BLM) maintains an interest in protecting candidate species under their sensitive species policy (BLM Manual 6840), with the goal that actions on BLM administered lands consider the welfare of these species and do not contribute to the need to list any of the sensitive species under the provisions of the ESA.

Anadarko Petroleum Company has notified the BLM, Rawlins Field Office that Anadarko and other cooperators intend to drill additional exploration and development wells within the Atlantic Rim Project Area (ARPA). While the Atlantic Rim Environmental Impact Statement (EIS) is being prepared, BLM has allowed the interim drilling of about 116 natural gas wells in six pod locations within the ARPA. The objective of the interim drilling program is to allow the ARPA operators to drill, complete, and produce the wells to determine which geologic objectives are gas productive, which drilling and completion techniques are economical, if dewatering of the drilling objectives can be achieved, and what depths or pressure windows may be preferred to target economic gas production. In addition to those wells drilled under the Atlantic Rim IDP, 210 previously approved wells, with accompanying production-related facilities, also exist within the ARPA.

Four alternatives have been developed for the proposed project: the Proposed Action, Alternative A (no action), Alternative B (sequential development), and Alternative C (spatial). Descriptions of each alternative are discussed in detail in Chapter 2 of the Draft Environmental Impact Statement (DEIS) (USDI-BLM 2005) and are summarized below.

Proposed Action

The proponents for the Atlantic Rim project propose the following:

- The Proposed Action consists of drilling approximately 1,800 CBNG wells to and throughout the Mesa Verde formation targeting the coals. In addition, approximately 200 conventional gas wells targeting sands at deeper depths are proposed throughout the project area, totaling 2000 wells all together. The planned production and development activities would occur primarily in and adjacent to the existing POD locations.

- The drilling activities for the 2,000 natural gas wells would be in addition to the approximately 116 ARPA exploration wells drilled during the interim drilling period. Also, this proposal is in addition to the 210 existing wells previously approved by the BLM for drilling to deeper, conventional formations in the ARPA prior to this proposed action.

- Proposed well spacing is 8 wells per section (80 acre spacing) throughout the project area and may be reduce to 4 wells per sections dependent on the geology and ability to release the water and pressure sufficient to release and recover the gas.

- Development would begin in 2006 (subsequent to the release of the Record of Decision) within the ARPA and continue for approximately 20 years, with a life-of-project (LOP) of

30-50 years. Various drilling and production related facilities (e.g., roads, pipelines, water wells, disposal wells, compressor stations, and gas processing facilities) would also be constructed throughout the ARPA. The proposed action does not include any overhead or newly buried electrified lines.

- Under the proposed action, there would be approximately 4,500 acres of new short term (initial) surface disturbance from well pad locations and associated facilities 1,000 miles (approximately 9,700 acres) of new roads or upgrades of existing roads; 1,015 miles (about 5,460 acres) of new gathering gas and water pipelines; and 1,480 acres of ancillary facilities. The total new short-term (initial) disturbance resulting from the proposed action would be about 15,800 acres.

- Under the Proposed Action, planned reclamation would reduce the total acres of disturbance to 6,241 acres of long term (LOP) disturbance.

Alternative A – No Action

NEPA regulations require that EIS alternative analyses in the EIS "include the alternative of no action" (40 CFR 1502.14(d))." For this analysis, "no action" means that the BLM would reject the Proponent's' proposal and "the proposed activity would not take place".

Alternative B – Sequential Development

Alternative B involves the same number and spacing of wells to be drilled as in the proposed action. However, the principle difference would be that the of development (drilling and associated construction activity) would occur in three phases with the center portion of the project area (vicinity of Doty Mountain Pod, Sundog / Cow Creek Pod and Blue Sky Pod) being developed first over a 6 to 7 year period. As in the proposed action, the entire project area would eventually be developed over the planned twenty year period. The initial phase would involve up to 925 well locations within the Phase 1 portion of the project area. Once completed and in production, development would then be shifted to the second phase in the northern portion of the project area and lastly, the third phase in the southern portion of the project area would be developed. The boundary between Phase 1 and Phase 2 lies along Muddy Creek and the boundary between Phase 1 and Phase 3 lies along a watershed divide and is delineated to keep intact a mule deer migration corridor based on data from the Wyoming Game and Fish Department. There would be continued drilling within previously analyzed PODs under the existing interim drilling plan concurrently with development of the initial phase. However, this drilling and facility development would be limited.

Under this alternative, development would be concentrated to one third of the project area at any one time, thereby concentrating surface disturbing activities, such as traffic and noise. Each phased area or zone would contain two to three of the original PODs from the interim drilling program. The center, Phase 1 area, containing of the Doty Mountain, Cow Creek/Sun Dog, and Blue Sky PODs, would be the first to be developed. The other two zones would be in-active in the sense that construction activities would not occur Development in those areas would not commence until drilling and interim reclamation operations are completed in the first phase areas and then the next.

POD boundaries would remain the same as they exist and were originally proposed. No additional development would occur outside the POD boundaries in inactive zones. BLM would authorize suspensions of operations and production for all leases within the no-activity areas except for where existing oil and gas development has already occurred. Proposals to develop

leases within non-active zones would be denied until the zone in which it is located becomes active for development under the Atlantic Rim ROD. For those leases suspended by the BLM no lease rental fees would accrue and the lease term will be tolled during the period the zone remained in a "no activity" status. Active status would last from 6-7 years per zone and would include completion of interim reclamation.

Gas production operations would begin and continue within an active zone as construction occurs. The extent of gas production facilities would continue to accumulate as time passes with ultimately the same level of operational (production) disturbance as the other action alternatives at completion. Once developed, production would continue throughout the project area.

Alternative C - Spatial
Development for natural gas would occur as in the proposed action, but would be conditioned with the application of required development protection measures in those areas with sensitive or crucial resource values. Generally, constraints would focus on surface disturbance limits, limited operating periods, modification of drilling and construction practices, and, in some cases, no surface occupancy. Resource data, in the form of GIS layers, would be used to identify specific areas of resource concern. Examples of such areas are: unique cultural values, crucial wildlife and fish habitat, and areas with fragile soils. These types of areas are unique enough to require additional protective measures beyond what is already provided by applying the standard Best Management Practices (BMPs) (Appendices H and J), lease stipulations, and Conditions of Approval (COAs). As a end product, geographic information system (GIS) layers would be available to operators for development of site specific proposals for their planning of the annual program of work. Further details on development protection measures proposed are detailed in Chapter 2, Alternative C.

1.1 Project Area Location

The ARPA is located in the southwestern corner of Wyoming's Carbon County, within Townships 13 through 20 North (T13-20N) and Ranges 89 through 92 West (R89-92W) of the 6th principal meridian. The project area encompasses approximately 270,000 acres. Of this total, approximately 174,000 acres are managed by the U.S. Department of the Interior (USDI) BLM; 14,000 acres are managed by the State of Wyoming; and about 82,000 acres are private lands. A detailed description of the project area location can be found in Section 1.1 of the DEIS (USDI-BLM 2005).

2.0 Methods

The assessments and recommendations contained within this BA are based upon information obtained from several sources: (1) published literature, (2) unpublished agency reports and data, (3) personal communications with state and federal agency wildlife specialists, (4) meetings with state and federal agency plant and wildlife specialists, and (5) field surveys.

2.1 Published Literature

Published scientific documents that pertain directly to the specific circumstances and issues involved in this analysis were reviewed and incorporated into this BA. All published literature used in this assessment is appropriately cited.

2.2 Unpublished Agency Reports and Data

Unpublished documents and data sets from the files of the Wyoming Game and Fish Department (WGFD) and U.S. Fish and Wildlife Service (FWS) were reviewed, utilized, and referenced in this BA. All available information on threatened and endangered species in the project area was reviewed in the preparation of the DEIS and this document. Materials reviewed include distribution and habitat maps, progress reports, recovery plans, sighting records, management plans, and survey guidelines for threatened and endangered species.

Some information concerning historical wildlife usage of the project area was obtained through the Rawlins BLM Field Office and District IV biologists of the WGFD. This information was specific to current and historical locations for wildlife species. Additional information was obtained from the WGFD, which maintains a computerized listing of all wildlife species reported in an area. This listing, known as the Wildlife Observation System (WOS) was accessed for information concerning all species of wildlife (birds, mammals, amphibians, and reptiles) that have been observed and recorded within the ARPA and a township buffer (T12-21N, R88-93W) as residents or seasonal migrants. The Wyoming Natural Diversity Database (WYNDD) was also queried for reports of rare or unique plant and wildlife species within the ARPA.

2.3 Personal Communications

Individuals interviewed during the fact-finding process, either directly or by telephone, included: Mr. Frank Blomquist (BLM Wildlife Biologist, Rawlins, WY), Ms. Pat Deibert (FWS Biologist, Cheyenne, WY), Ms. Kathleen Erwin (FWS Biologist, Cheyenne, WY), Mr. Walt Fertig (WYNDD Heritage Biologist, Laramie, WY), Ms. Mary Read (BLM Wildlife Biologist, Rawlins, WY), Mr. Andy Warren (BLM Supervisory Rangeland Management Specialist, Rawlins, WY), Mr. Greg Hiatt (WGFD Wildlife Biologist, Sinclair, WY) and Mr. Tim Woolley (WGFD Wildlife Biologist, Baggs, WY).

2.4 Meetings

Numerous meetings were held among state and federal wildlife specialists and Hayden-Wing Associates (HWA) concerning potential impacts to wildlife that may result from the proposed project. All of the concerns raised in these meetings regarding development of the proposed project have been addressed in either this document or the DEIS (USDI-BLM 2005).

2.5 Field Surveys

Existing special status wildlife information for the project area was supplemented through wildlife surveys conducted by HWA from 2000 to 2004. These data collections consisted of aerial and ground surveys to determine: (1) occurrence of threatened, endangered, proposed, candidate, or sensitive species and/or habitat that may occur on the project area; (2) the occurrence, location, size, and burrow density of white-tailed prairie dog colonies; and (3) the location and activity status of raptor nests within the project area and one-mile buffer zone.

2.6 BA Preparation

Personnel who cooperated in the preparation of this BA include the following: L.D. Hayden-Wing, principal investigator of HWA and a member of the Inter-Disciplinary Team, supervised the collection of wildlife data and compilation of the overall document. T. Olson, wildlife biologist

with HWA and B. Parkhurst assisted in the preparation of the document. J. Winstead, K. Jones, T. Olson, L. Bennett, and D. Knowlton, wildlife biologists with HWA, assisted in the collection of field data.

3.0 Current Status and Habitat Use of Species

The FWS has determined that nine species, which are listed under the ESA as either threatened, endangered or proposed, or are candidates for listing under the ESA, are potentially present within the Rawlins BLM Field Office (USDI-FWS 2004a; Table 1). Additionally, ten species that are found downstream of the Rawlins Field Office in the Platte and Colorado River systems may potentially be impacted if water depletions occur. These species and their federal status under the ESA are listed in Table 1.

Table 1. Threatened, endangered, proposed, or candidate species that may potentially be present within the Rawlins BLM Field Office or that may potentially be impacted by the Proposed Action.

Common Name	Scientific Name	Status
Mammals		
Black-footed ferret	*Mustela nigripes*	Endangered
Canada lynx	*Lynx canadensis*	Threatened
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Threatened
Birds		
Bald eagle	*Halieaeetus leucocephalus*	Threatened
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate
Whooping crane*	*Grus americana*	Endangered
Interior least tern*	*Sterna antillarum*	Endangered
Piping plover*	*Charadrius melodus*	Threatened
Eskimo curlew*	*Numenius borealis*	Endangered
Amphibians		
Wyoming toad	*Bufo baxteri*	Endangered
Fish		
Colorado pikeminnow**	*Ptychocheilus lucius*	Endangered
Bonytail**	*Gila elegans*	Endangered
Humpback chub**	*Gila cypha*	Endangered
Razorback sucker**	*Xyrauchen texanus*	Endangered
Pallid sturgeon*	*Scaphirhynchus albus*	Endangered
Plants		

Common Name	Scientific Name	Status
Blowout penstemon	*Penstemon haydenii*	Endangered
Ute-ladies'-tresses	*Spiranthes diluvialis*	Threatened
Colorado butterfly plant	*Gaura neomexicana ssp. coloradensis*	Threatened
Western prairie fringed orchid*	*Platanthera praeclara*	Threatened

* water depletions in the Platte River system may affect these species found downstream of the ARPA.
** water depletions in the Colorado River system may affect these species found downstream of the ARPA.

3.1 Threatened, Endangered, Proposed, and Candidate Species

Black-footed Ferret

The black-footed ferret's original distribution in North America closely corresponded to that of prairie dogs (Hall and Kelson 1959, Fagerstone 1987). In Wyoming, prairie dog (*Cynomys* spp.) colonies provide essential habitat for black-footed ferrets. Ferrets depend almost exclusively on prairie dogs for food and they also use prairie dog burrows for shelter, parturition, and raising young (Hillman and Clark 1980, Fagerstone 1987). Prairie dog towns occurring within the project area were initially located from the air and subsequently mapped from the ground in their entirety. Prairie dog colonies were mapped from an ATV or on foot using a hand-held GPS receiver. Additional studies identified a total of 295 white-tailed prairie dog colonies, comprised of 6,300 acres (2.3% of the area) existing within the ARPA.

On February 2, 2004, the U.S. FWS issued a letter stating that, in Wyoming, surveys for black-footed ferrets are no longer warranted in black-tailed prairie dog complexes and in many white-tailed prairie dog complexes, except for sixteen non-block cleared white-tailed prairie dog complexes (USDI-FWS 2004b). One of these complexes, the Dad Complex is located partially within the ARPA. For the ARPA, a total of 273 white-tailed prairie dog colonies covering 5,720 acres within the Dad Complex and are not included under the block clearance. Therefore, surveys for black-footed ferrets may be warranted prior to ground disturbing activities within these prairie dog colonies. Surveys would be conducted according to U.S. FWS guidelines (USDI-FWS 1989). The remaining white-tailed prairie dog colonies within the ARPA have been block cleared and surveys for black-footed ferrets are no longer warranted. However, these towns located within the block-clearance area should be examined for their potential to provide habitat for relocation of black-footed ferrets.

Canada Lynx

The Canada lynx is one of three major species of wildcats found in North America. Although Wyoming comprises part of the species' historic geographical range, no lynx sightings have been documented in the ARPA or within a six-mile buffer (WGFD 2003). The closest known sighting of a lynx to the ARPA is approximately 55 miles to the east (Reeve et al. 1986 and Beauvais et al. 2001). In a collaborative effort, the BLM and WYNDD completed a lynx habitat suitability map for the State of Wyoming (Beauvais et al. 2001); according to the habitat map, lands within the ARPA provide low to poor quality lynx habitat. Lynx could potentially travel through the ARPA, but the likelihood of this is very low due to a lack of suitable habitat.

Due to the facts that: (1) the project area does not include high elevation lodgepole pine/spruce-fir habitat types preferred by this species, (2) the project area does not support a population of

snowshoe hares (WGFD 2003), (3) there are no recorded lynx sightings within a six-mile buffer in either the WOS (WGFD 2003) or the WYNDD (2003), and (4) the closest potential habitat is approximately 6 miles to the east in the Sierra Madre Mountains, it is unlikely that lynx occur on or near the ARPA and is therefore not discussed further in this document.

Preble's Meadow Jumping Mouse

In Wyoming, Preble's meadow jumping mouse is found within riparian habitat corridors east of the Laramie Range Mountains and south of the North Platte River (USDI-FWS 2004a). Preble's meadow jumping mouse is closely related to the western jumping mouse, and subspecies are generally identified by geographic location (Beauvais 2000). The ARPA is located more than 100 miles west of the known distribution of the Preble's meadow jumping mouse and this species is not expected to occur on the project area and is therefore not discussed further in this document.

Bald Eagle

Bald eagles typically build stick nests in the tops of coniferous or deciduous trees along streams, rivers, or lakes. Selection of nest sites likely depends upon availability of food in the early nesting season (Swenson et al. 1986). Although no bald eagle nests or nesting habitat occurs on the project area, nesting habitat does occur south of the project area along the Little Snake River. Primary wintering areas are typically associated with concentrations of food sources including major rivers that remain unfrozen where fish and waterfowl are available and ungulate winter ranges where carrion is available (Montana Bald Eagle Working Group 1990).

Bald eagles have been observed on the project area primarily during December, January, and February (WGFD 2003). The majority of bald eagle locations on the project area are in the southern portion of the ARPA, close to the Little Snake River. Bald eagles may utilize the project area for foraging during winter months because a large portion consists of winter range for antelope, mule deer, and elk.

The bald eagle winters and nests in proximity to the project area along the Little Snake River. Several ecological factors probably allow for seasonal and/or year-round use by bald eagles along the Little Snake River: (1) some water may remain open on the river year-round providing an adequate supply of fish and waterfowl, (2) the river is adjacent to crucial ungulate winter range, and (3) the riparian zone has many large cottonwood trees for roosting and nesting. This habitat along the Little Snake River is located ½ to 2 miles south of the ARPA. Upland habitat use by bald eagles within the project area would probably be limited to winter scavenging forays. Few trees large enough for eagle roosting or nesting exist on the project area. Inspection of BLM raptor nest records, WGFD WOS records, and results of aerial and ground raptor nest surveys performed by HWA revealed that no bald eagle nests occur within the ARPA.

Yellow-billed Cuckoo

The yellow-billed cuckoo is a neotropical migrant that winters in South America and breeds from southeast Canada, throughout most of the United States (except the northern Great Plains to the northwest coast) and northern Mexico (Payne 1997). In North America, the cuckoo population is divided into two subspecies. The population west of the Continental Divide is considered the Western or California subspecies and the population east of the Continental Divide is the Eastern subspecies. Trends developed from Breeding Bird Survey (BBS) data indicate that the yellow-billed cuckoo is declining throughout its range but the most dramatic declines have been associated with the Western subspecies. As a result, the yellow-billed

cuckoo has twice been petitioned as an endangered species pursuant to the Endangered Species Act (ESA). The Southwest Region of the U.S. Fish and Wildlife Service rejected the first petition submitted in 1987. The second petition was submitted in 1998 and called for the listing of cuckoos west of the Continental Divide as a subspecies or a geographically, morphologically, behaviorally, and ecologically distinct population from cuckoos east of the Continental Divide. In July 2001, the FWS concluded that the petitioned action was warranted but precluded by higher priority listing actions. Currently, the western subspecies of yellow-billed cuckoo (located west of the Continental Divide) is considered a candidate species.

Observations of the yellow-billed cuckoo in Wyoming are very rare, with approximately 24 documented observations since 1982 (Bennett 2002). The yellow-billed cuckoo is a BLM sensitive species throughout all of Wyoming and it may be found in cottonwood/riparian habitats below 7,000 feet and in urban areas throughout the state (WGFD 1999). In Wyoming, it is thought to prefer cottonwood stands for foraging and willow thickets for nesting. The ARPA does not include any large riparian areas with well-developed cottonwood/riparian habitats, therefore it is unlikely that the yellow-billed cuckoo occurs on the project area and it has not been documented on the ARPA (WGFD 2003, WYNDD 2003) and is therefore not discussed further in this document.

Wyoming Toad

The Wyoming toad was historically associated with floodplain ponds along the Big and Little Laramie Rivers in Albany County (Baxter and Stone 1992). Currently, the Wyoming toad is only known to occur at Mortenson Lake National Wildlife Refuge. However, reintroduction efforts are underway in other portions of its former range. The Wyoming toad did not historically, and does not currently occur on or near the ARPA and is therefore not discussed further in this document.

Blowout Penstemon

Blowout penstemon is a member of the Scrophulariaceae (Figwort) family (Fertig 2001) and is probably the rarest plant species native to the Great Plains (Nebraska Game and Parks Commission [NGPC] 2002). The species is most common in the open, sandy habitats of wind-excavated depressions (blowouts) in dune tops. In Wyoming, the species has also been documented on very steep, unstable sand dunes (Fertig 2000). Within these limited habitats, this short-lived perennial frequently occurs in large, multi-stemmed clumps. In June and July, when in bloom in Wyoming, its lavender-purple flowers stand out against other sparse vegetation found in and around sandy blowouts. In addition to features of its leaves and flowers, blowout penstemon's lavender or vanilla-like fragrance distinguishes it as only one of two fragrant species of the 300 penstemons in the world (NGPC 2002).

The reproductive life history of the species has led, in part, to the decline of blowout penstemon populations in Wyoming and other native regions. The primary limiting factor in seedling establishment is moisture availability. For blowout penstemon seeds to germinate, and for the roots to reach a depth where moisture is available and constant, blowout sand must remain damp for at least two weeks during the growing season (NGPC 2002). In the arid environment of sandy blowouts, these conditions usually only occur in one out of every eight to ten years (NGPC 2002). Exacerbating the effects of limited germination and establishment conditions is the loss of blowout habitats. Active fire suppression programs and improved range management practices have led to increases in prairie vegetation cover with decreases in sandy areas. The species now remains in only a few locations where wind erosion has maintained sandy blowouts (NGPC 2002).

Blowout penstemon is known to occur in certain habitats south of the Ferris Mountains in the northern part of Carbon County. The plant has the potential to occur on the project area (Fertig 2001, USDI-FWS 2002), especially in the Sand Hills area where a few, active sand dunes are known to exist (Warren 2002). However, the species was not found during field surveys of this area by WYNDD personnel in June 2000 (Fertig 2000).

Ute ladies'-tresses

Ute ladies'-tresses is a perennial, terrestrial orchid with stems 8 to 20 inches tall, and flowers consisting of white or ivory flowers clustered into a spike arrangement at the top of the stem. The plant blooms mainly from late July through August, however, depending on location and climatic conditions, it may bloom in early July or still be in flower as late as early October. Habitat for Ute ladies'-tresses can occur in major riparian corridors subject to fluvial erosion/deposition, or more ideally, in moist to very wet meadows along streams. It has also been found in abandoned stream meanders that still have ample ground water, near springs, and lakeshores. The habitat on which the species depends has been drastically modified by urbanization, agriculture, and development (description adapted from NatureServe 2003).

Ute ladies'-tresses was designated as threatened in 1992 when it was only known from Colorado, Utah, and Nevada. Since that time, it has been found in Wyoming, Montana, Nebraska, and Idaho (NatureServe 2003). The known locations of the species in Wyoming include Converse, Goshen, Laramie, and Niobrara Counties. Much of the ARPA is located above the upper known elevation of occurrence (6,800 feet) for this species (Fertig 2002) and the species is not known to occur within the ARPA. However, some areas along the eastern portion of the ARPA may contain marginal habitats for the Ute ladies'-tresses.

Colorado Butterfly Plant

The Colorado butterfly plant is a short-lived perennial herb that typically occurs on sub-irrigated soils on level or slightly sloping floodplains and drainage bottoms at elevations of 5,000-6,400 feet (Fertig 2000). The species is often found a short distance from meandering stream channels. This species is known to occur in Laramie County in southeastern Wyoming, in southwestern Nebraska and in northeastern Colorado. This species is not known and is not expected to occur on or near the ARPA and is therefore not discussed further in this document.

3.2 Colorado River Species

Within the ARPA, a total of approximately 284 miles of intermittent, ephemeral, and perennial streams occur. Perennial surface water is relatively scarce within the ARPA due to limited precipitation (5.8 - 24.3 inches/year). The majority of drainages within the ARPA are ephemeral drainages. Ephemeral waters are those in which the water table is always below the stream channel and only flow in direct response to precipitation or snow melt. Ephemeral waters only support very limited aquatic communities for the short periods when surface flow is present. However, Muddy Creek, its tributaries McKinney Creek and Littlefield Creek, and Savery Creek are perennial streams and are classified as Class 2 and 3 streams by the WDEQ, which support game and non-game species. These streams are considered to be locally to regionally important trout fisheries by the WGFD (1991, 1998).

About 15 reservoirs and ponds (0.5 - 20 acres) are present within the Colorado River Watershed portion of the ARPA. Some of the ponds and reservoirs that currently exist within the ARPA are fed by waters recovered from wells drilled at upstream locations, while others are

impoundments on small drainages. These man-made impoundments are generally designed to supply water for livestock and wildlife use.

Four federally endangered fish species may occur as downstream residents of the Colorado River system: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USDI-FWS 2004a). The Colorado pikeminnow, bonytail, and humpback chub are all members of the minnow family. The razorback sucker is a member of the sucker family. All four of these fish species share similar habitat requirements and historically occupied the same river systems.

The last sighting of any of these fish species in the Little Snake River was of a single Colorado pikeminnow in 1990. Because habitat for these species is not present within the ARPA, these fish species are not likely to be found in tributaries to the Little Snake River within the ARPA, and critical habitat for these species has not been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999). However, the potential for project-related reductions in water quantity and/or quality to these tributaries to the Colorado River warrant their inclusion in this document.

Colorado Pikeminnow

The Colorado pikeminnow is the largest member of the minnow family and occurs in swift, warm waters of Colorado Basin rivers. The species was once abundant in the main stem of the Colorado River and most of its major tributaries throughout Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and Mexico. It was known to occur historically in the Green River of Wyoming at least as far north as the City of Green River. In 1990, one adult was collected from the Little Snake River in Carbon County, Wyoming (Baxter and Stone 1995). Subsequent survey attempts to collect Colorado pikeminnow from this area of the Little Snake River by WGFD personnel failed to yield any other specimens.

Bonytail

Habitat of the bonytail is primarily limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the bonytail is thought to be the rarest of the endangered fishes in the Colorado River System.

The bonytail historically inhabited portions of the upper and lower Colorado River basins. Today, in the upper Colorado River Basin, only small, disjunct populations of bonytail are thought to exist in the Yampa River in Dinosaur National Monument, in the Green River at Desolation and Gray Canyons, in the Colorado River at the Colorado/Utah border and in Cataract Canyon (Upper Colorado River Endangered Fish Recovery Program 1999).

Humpback Chub

Habitat of the humpback chub is also limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999). The humpback chub was historically found throughout the Colorado River System, and its tributaries, which are used for spawning (Valdez et al. 2000). It is estimated that the humpback chub currently occupies 68% of its original distribution in five independent populations that are thought to be stable (Valdez et al. 2000).

Razorback Sucker

The razorback sucker is an omnivorous bottom feeder and is one of the largest fishes in the sucker family. Adult razorback sucker habitat use varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today, in the Colorado River Basin, populations of razorback suckers are only found in the upper Green River in Utah, the lower Yampa River in Colorado and occasionally in the Colorado River near Grand Junction (Upper Colorado River Endangered Fish Recovery Program 1999).

3.3 Platte River Species

A small portion of the ARPA drains into the Platte River system and according to the FWS (USDI-FWS 2004a), water depletions in the Platte River system may contribute to the destruction or adverse modification of designated critical habitat for the following species. None of these species or their habitats are found within the ARPA, but they could be impacted by actions taken on the ARPA.

Whooping Crane

Critical habitat for the whooping crane downstream of the ARPA is located along the Platte River Bottoms between Lexington and Dehman, Nebraska (Federal Register 1978). Whooping crane habitat consists of large expanses of wetlands that provide suitable food (insects, crayfish, frogs, small fish) and open expanses near wetlands for nightly roosting (Federal Register 1978).

Interior Least Tern

The interior least tern nests on un-vegetated sand-pebble beaches and islands of large reservoirs and rivers. Interior least terns avoid areas where relatively thick vegetation provides cover for potential predators. No habitat for the interior least tern is found on the ARPA, but habitat is located downstream of the ARPA along the Platte River in Nebraska (USDI-FWS 1990).

Piping Plover

Critical habitat for the piping plover includes prairie alkali wetlands and surrounding shoreline, including 200 feet of uplands above the high water mark; river channels and associated sandbars, and islands; reservoirs and their sparsely vegetated shorelines, peninsulas, and islands; and inland lakes and their sparsely vegetated shorelines and peninsulas (Federal Register 2002). Critical habitat for the species downstream of the ARPA in Nebraska begins at the Lexington Bridge and extends to the Platte's confluence with the Missouri River 252 mi (405.5 km) downstream (Federal Register 2002). Approximately ¼ of this part of the Platte River is also designated as critical habitat for the whooping crane. Open shorelines and sandbars of rivers, large reservoirs, alkali wetlands, lakes and rivers provide suitable breeding habitat for the piping plover.

Eskimo Curlew

The eskimo curlew migrates from wintering grounds in the pampas of Argentina, northward through Central America and the central Great Plains of North America to breeding grounds in northern Canada and Alaska (Gollop et al. 1986). The spring migration route passes through Nebraska (Gollop et al. 1986), where the birds may stopover along the Platte River. In the fall they migrate eastward to Labrador, then south over the Atlantic Ocean back to South America (Gollop et al. 1986). Habitat for the eskimo curlew includes grasslands, tundra, burned prairies, plowed fields, marshes, mudflats, meadows, and pastures. Burned prairies and marshes may

be attractive during migration (Gollop et al. 1986). The loss of prairie habitat in North America may have contributed to the decline of the eskimo curlew, but the primary reason for the rarity of the bird was market hunting in the late 1800s and early 1900s (Gollop et al. 1986). No suitable habitat for the eskimo curlew occurs on the ARPA and the species has not been reported within or near the ARPA (WGFD 2003, WYNDD 2003).

Pallid Sturgeon

The pallid sturgeon is a native fish found in the Mississippi/Missouri River system. The pallid sturgeon is present in the Platte River, a tributary to the Missouri River, located downstream from a portion of the ARPA. Suitable habitat for the pallid sturgeon consists of large turbid rivers with sand or gravel bottoms. The pallid sturgeon is threatened by habitat degradation such as decreased turbidity, which can be caused by impoundments.

Western Prairie Fringed Orchid

The western prairie fringed orchid is a long-lived perennial herb with stems that can grow to 1.2 m tall from an underground tuber. The plant blooms for about a three-week period starting in mid-June in the southern portion of its range to late July in the north. Habitat of the western prairie fringed orchid is the western portions of the North American tallgrass prairie and it is most commonly observed on moist, calcareous soils, sub-saline prairies and sedge meadows (many flooded for a period of 1-2 weeks during the year). Published accounts and herbarium records suggest that this plant was widespread and perhaps locally common prior to European settlement. Declines are due to the extensive and on-going conversion of the tallgrass prairie to agricultural uses throughout its range (description adapted from NatureServe Explorer 2004).

The western prairie fringed orchid was designated as a threatened species in its entire range in 1989. Within the area covered by this listing, this species is known to occur in Iowa, Kansas, Minnesota, Missouri, North Dakota, Nebraska, Oklahoma, and in Manitoba Province, Canada (NatureServe 2003).

4.0 Direct and Indirect Impacts of the Proposed Project

Although the total acres of wildlife habitat that would be disturbed under the action alternatives over the next twenty years is known, the distribution of this disturbance will not be known until actual site specific well locations and other disturbance activities are determined. Therefore, in order to assess the direct and indirect impacts of the proposed project, it was assumed that any section of land may potentially be developed at the level of 8 locations per section under the Proposed Action and Alternative B. Under Alternative C disturbance levels would be reduced. The extent of disturbance reduction would be determined by the site specific proposals that come forward and the development protection measures that apply.

4.1 Proposed Action

Under the Proposed Action up to 15,800 acres of wildlife habitat would be disturbed by construction activities over the next 20 years. With concurrent reclamation of disturbed habitats the total un-reclaimed disturbance area at any given point in time would never equal the sequential total. Under the Proposed Action, reclamation would reduce impacts to about 6,200 acres or 2.3% of the ARPA by the end of the development phase of the project. Reclamation success will be influenced by timing of reclamation and climatic conditions.

4.1.1 Threatened, Endangered, Proposed, and Candidate Species

Black-footed Ferret

295 white-tailed prairie dog colonies, comprised of 6,300 acres (2.3% of the area) existing within the ARPA. A total of 273 white-tailed prairie dog colonies within the ARPA, covering 5,720 acres, are located within the Dad Complex and are not included under the block clearance. These colonies meet requirements for consideration as black-footed ferret habitat (Biggins et al. 1989). Development of the Proposed Action would likely result in direct disturbance of some portions of these prairie dog colonies.

Surveys for black-footed ferrets may be required prior to ground disturbing activities within prairie dog colonies located in the Dad Complex. Surveys would be conducted according to U.S. FWS guidelines (USDI-FWS 1989). The remaining white-tailed prairie dog colonies within the ARPA are in the "block clearance" area, where surveys for black-footed ferrets are no longer required. However, these towns located within the block-clearance area should be examined for their potential to provide habitat for relocation of black-footed ferrets.

Projects would not be authorized within white-tailed prairie dog colonies within the Dad Complex unless surveys for black-footed ferrets have been completed. If surveys are required, consultation with the FWS will be initiated prior to surveys being conducted. If black-footed ferrets are found, no project related disturbance will occur within the prairie dog complex and all project related activities in such towns or complexes shall be suspended immediately. The FWS will be notified within 24 hours if a black-footed ferret or their sign is observed. Although black-footed ferrets may be affected by this project, as long as the prescribed avoidance and protective measures (listed in the *Conservation Measures* section) are implemented, they are unlikely to be adversely affected.

Bald Eagle

Bald eagles have been observed on the project area primarily during December, January, and February (WGFD 2003). The majority of bald eagle locations on the project area are in the southern portion of the ARPA, close to the Little Snake River. Bald eagles may utilize the project area for foraging during winter months because a large portion consists of winter range for antelope, mule deer, and elk.

Upland habitat use by bald eagles within the project area would probably be limited to winter scavenging forays. Few trees large enough for eagle roosting or nesting exist on the project area. Inspection of BLM raptor nest records, WGFD WOS records, and results of aerial and ground raptor nest surveys performed by HWA revealed that no bald eagle nests occur within the ARPA.

The southern portion of the project area, closest to the Little Snake River, has the highest potential for bald eagle occurrence. This portion of the ARPA contains crucial winter range for elk, mule deer, and pronghorn. The potential for vehicle collisions with big game would increase as a result of increased vehicular traffic associated with the presence of construction crews and activities in the project area. Because bald eagles commonly feed on carrion, particularly during the winter months, the presence of road-killed big game carcasses on and adjacent to the access roads is an attractant. Eagles feeding on these carcasses are in danger of being struck by moving vehicles. Any increase in the death rate of bald eagles from vehicular collisions will constitute a significant impact. Because the potential for an increase in the incidence of big game-vehicle-eagle encounters exists, measures to avoid and/or reduce such incidents will be

taken. Such measures shall include: (1) requirement that regular drivers undergo training describing the circumstances under which vehicular collisions with bald eagles are likely to occur and the measures that can be employed to minimize them, including reduced speeds, (2) prohibition of unnecessary off-site activities of operational personnel and inform all project employees of applicable wildlife laws and penalties associated with unlawful take and harassment, (3) removal of vehicle-killed carcasses from the ROWs of access roads on the project area to eliminate the exposure of carrion-feeding eagles to the threat of being struck by vehicles, and (4) operators will internally enforce existing drug, alcohol, and firearms policies. Given the implementation of these measures, the bald eagle may be affected, but is not likely to be adversely affected.

Blowout Penstemon

Blowout penstemon is known to occur in certain habitats south of the Ferris Mountains in the northern part of Carbon County. The plant has the potential to occur on the project area (Fertig 2001, FWS 2002) only in the Sand Hills area where a few active sand dunes are known to exist (Warren 2002). However, the species was not found during field surveys of this area by WYNDD personnel in June 2000 (Fertig 2000). Given the presence of potential habitat within the ARPA, implementation of the action alternatives may directly impact some individual plants of this species. Should this species be found within the ARPA, the specific sites where it is found would be avoided to prevent any potential impacts.

Ute Ladies'-tresses

The known locations of Ute ladies'-tresses in Wyoming include Converse, Goshen, Laramie, and Niobrara Counties. Potentially suitable habitats for this species are very limited within the ARPA. This species is not known to occur within the ARPA and the likelihood of it occurring in the ARPA is low due to the following reasons: (1) much of the ARPA is very arid and there are few perennial streams, (2) the elevation of the project area is near the upper limit for the species, (3) very few moist riparian area meadows are present, (4) the transition from stream margins to upland vegetation is abrupt, and (5) the species has only been located in eastern and southeastern Wyoming (Fertig 2002). Given the presence of potential habitat within the ARPA, there is a slight chance of impacts due to the low likelihood of it occurring. If this species is found within the ARPA in the future, the specific sites where it is found would be avoided to prevent any potential impacts.

4.1.2 Colorado River Species

Four federally endangered fish species may occur as downstream residents of the Colorado River system: Colorado pikeminnow, bonytail, humpback chub, and razorback sucker (USDI-FWS 2004a). All four of these fish species share similar habitat requirements and historically occupied the same river systems. Declines in populations of these species are mainly attributed to impacts of water development (e.g. dams and reservoirs) on natural temperature and flow regimes, creation of migration barriers, habitat fragmentation, the introduction of competitive and predatory non-native fishes, and the loss of inundated bottom lands and backwater areas (Minckley and Deacon 1991, USDI-FWS 1993).

Under the action alternatives, no produced water will be discharged to the Colorado River system; therefore, produced water discharges do not pose a risk to these species. Implementation of all appropriate mitigation measures for water resources and soils identified in the ARPA would prevent potential downstream sedimentation and/or contamination caused by

construction activities. Therefore, water quality in the Colorado River system is not expected to be impacted under any of the action alternatives.

Limited water depletions within the Colorado River system are expected from drilling activities within the ARPA. Water depletion from the Colorado River system as a result of road/pad construction and dust abatement would be approximately 10.3 acre-feet per year for the entire project area, and a mitigation fee would not be applicable. Water depletions to the Colorado River system as a result of this project may adversely affect these four fish species. This determination is based on the Recovery and Implementation Program for Endangered Fish Species in the Upper Colorado River Basin which was initiated on January 22, 1988. The Recovery program was intended to be the reasonable and prudent alternative to avoid jeopardy to the endangered fish by depletions from the Upper Colorado River. A part of the Recovery Program was the requirement that if a project was going to result in a depletion, a depletion fee would be paid to help support the Recovery Program. On July 5, 1994, the Service issued a biological opinion determining that the fee for depletions of 100 acre-feet or less would no longer be required. This was based on the premise that the Recovery Program has made sufficient progress to be considered the reasonable and prudent alternative avoiding the likelihood of jeopardy to the endangered fishes and avoiding destruction or adverse modification of their critical habitat by depletions of 100 acre-feet or less.

4.1.3 Platte River Species

The whooping crane, interior least tern, piping plover, Eskimo curlew, pallid sturgeon, and western prairie fringed orchid are all found downstream of the ARPA along the Platte River. No habitat for any of these species occurs on the ARPA and they are not likely to occur there. Under any of the action alternatives, no produced water will be discharged to the Platte River system; therefore, produced water discharges do not pose a risk to these species. Implementation of all appropriate mitigation measures for water resources and soils identified in the ARPA would prevent potential downstream sedimentation and/or contamination caused by construction activities. Therefore, water quality in the Platte River system is not expected to be impacted under any of the action alternatives. No water depletion from the Platte River system will occur as a result of the proposed project.

4.2 Alternative A – No Action

Under Alternative A no wildlife habitat would be disturbed.

4.3 Alternative B – Sequential Alternative

Under this alternative construction activities would be focused into one of three discrete areas at any one time. This would localize and intensify wildlife and habitat disturbance within the area of construction activities, but would minimize disturbance throughout the remaining project area. Disturbance associated with operational activities would gradually increase throughout the ARPA as the project progresses and would be ultimately similar in effect to the Proposed Action when construction activities are completed.

4.4 Alternative C – Spatial

Development for natural gas would occur as in the proposed action, but would be conditioned with the application of required development protection measures in those areas with sensitive

or crucial resource values. These types of areas are unique enough to require additional protective measures beyond what is already provided by applying the standard Best Management Practices (BMPs) (Appendices H and I), lease stipulations, and Conditions of Approval (COAs). With a focus on surface disturbance limits, limited operating periods, modification of drilling and construction practices, and, in some cases, no surface occupancy surface disturbance extents would be limited to about 50 % of the Proposed Action and Alternative B. Resource data, in the form of GIS layers, would be used to identify specific areas of resource concern. Geographic information system (GIS) layers would be available to operators for their development of the annual program of work, and to the BLM in assessing and approving those proposals while reducing adverse impacts to those sensitive and / or crucial resource values.

5.0 Cumulative Impacts

The cumulative impact analysis (CIA) approach is used to evaluate the influences of recent, past, present, and reasonably foreseeable future human developments on the local wildlife resources. This approach examines impacts associated with a proposed project in context with all other past and future developments, whether or not they are related. It also allows the wildlife manager and land management agency to evaluate impacts on a broader scale. The BLM recommends evaluating cumulative impacts on a watershed basis for natural resources related to watershed function and stability.

Existing disturbance within the ARPA is approximately 763 acres, or around 0.28 percent of the 270,000 acres comprising the project area. During the construction phase, the Proposed Action and Alternative B would disturb up to 15,800 acres or 5.9 % of the overall project area. Alternative A (no action) would not disturb any acreage. Alternative C is estimated to disturb approximately half that of the Proposed Action or 7,900 acres for 2.9 % of the overall project area. Disturbance areas within the ARPA would be reduced upon reclamation of pipeline ROWs, unused portions of the drill pad, portions of roads, and ancillary facility disturbances during the production phase for each alternative, resulting in long-term disturbance of about 6,200 acres under the Proposed Action and Alternative B, 3,100 acres under Alternative C, and no acreage under Alternative A.

Black-footed Ferret

Provided that avoidance measures outlined in this document are followed, the potential for an incremental increase in cumulative impacts due to the implementation of the Proposed Action or Alternatives B or C may affect the black-footed ferret but is not likely to adversely affect the black-footed ferret.

Bald Eagle

Bald eagles are not known to nest on the ARPA, but may use portions of the project area, especially during winter months when carrion is available. Provided that avoidance measures outlined in this document are followed, the potential for an incremental increase in cumulative impacts due to the implementation of the action alternatives (Proposed Action, B, C) or Alternative A (No Action) may affect but is not likely to adversely affect the bald eagle.

Blowout Penstemon

Implementation of the any of the alternatives is not expected to contribute cumulative impacts upon blowout penstemon due to a lack of confirmed occurrences of the species within the

ARPA. Should surveys identify populations of blowout penstemon, such populations and associated habitats would be avoided.

Ute Ladies'-tresses

Implementation of the any of the alternatives is not expected to contribute to cumulative impacts upon Ute ladies-tresses due to a lack of confirmed occurrences of the species within the ARPA. Should surveys identify populations of blowout penstemon, such populations and associated habitats would be avoided.

Colorado River Species

On July 5, 1994, the Service issued a biological opinion determining that the fee for depletions of 100 acre-feet or less would no longer be required. This was based on the premise that the Recovery Program has made sufficient progress to be considered the reasonable and prudent alternative avoiding the likelihood of jeopardy to the endangered fishes and avoiding destruction or adverse modification of their critical habitat by depletions of 100 acre-feet or less. Cumulative impacts to the endangered fish species that are downstream of the ARPA in the Colorado River are expected to be less than 100 acre-feet per year from the project, under any of the alternatives.

Platte River Species

These species do not occur on the ARPA and no water depletions to the Platte River system are expected, therefore implementation any of the alternatives would not contribute to cumulative impacts upon these species.

6.0 Conservation Measures to Avoid or Reduce Adverse Impacts

The following procedures will be implemented to eliminate or substantially reduce potential adverse effects of the proposed project to threatened, endangered, proposed, candidate, and petitioned species that may occur on or near the ARPA or that may be impacted by the project.

- If disturbance of prairie dog colonies located within the Dad Complex can not be avoided, black-footed ferret surveys will be conducted according to FWS guidelines (USDI-FWS 1989) if the affected towns meet the survey requirements.
- Well pads and disturbances shall be placed outside of (50 m) prairie dog colonies where feasible. In the non-block cleared areas of the ARPA, any construction would require block surveys for the presence of black-footed ferrets. In those area that are block cleared, disturbance is minimized to limit disturbance to as few a burrows as possible.
- Should black-footed ferrets be documented in a prairie dog complex located within the project area, impacts to the species or its habitat will be suspended immediately.
- The operators shall conduct educational outreach to employees regarding the nature, hosts, and symptoms of canine distemper, and its effects on black-footed ferrets, focusing attention on why pets should be prohibited from work sites.
- All suspected observations of black-footed ferrets, their sign, or carcasses on the ARPA, however obtained, shall be promptly (within 24 hours) reported to the BLM and FWS.

- All drivers shall undergo a training session describing the type of wildlife in the area that are susceptible to vehicular collisions in order to reduce the potential for vehicle-big game collisions and subsequent jeopardy to bald eagles feeding on road-killed carrion. The circumstances under which such collisions are likely to occur, and the measures that could be employed to minimize them shall be discussed. Reduced speed limits shall be implemented to reduce potential for vehicle-wildlife collisions.

- Carcasses shall be removed from access roads, shoulders, and the ROWs to minimize bald eagle exposure to vehicles.

- Remote monitoring of project facilities would be utilized to the extent possible to reduce human activity levels within the gas field during the production phase.

- All appropriate sedimentation, erosion control, and produced water control measures included in the Record of Decision will be implemented to avoid changes in water quality or quantity in the streams within the ARPA.

- Construction equipment fueling and servicing areas shall be located at least 150 feet from surface water drainages and riparian areas and away from slopes that drain into those areas.

- High construction standards and rigid safety precautions that adhere to approved design criteria to minimize the potential for an accidental spill or discharge of any chemical or petroleum product into surrounding watershed systems shall be implemented.

- As a safety measure, buffer zones of undisturbed vegetation along water courses shall be maintained to inhibit transport of potentially contaminated runoff to surface waters.

7.0 Effects of the Project on the Expected Status of Species in the Future

Provided that the conservation measures described above are implemented, the proposed action and alternatives are not expected to alter the current status of, or result in any decreased survival of, any of the species discussed in this document during the project or after project completion.

8.0 Determination of Effects for Listed Species

Black-footed Ferret

Based upon the analyses of the alternatives, the current and potential status of the species in the project area, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that implementation of the alternatives **may affect** but is **not likely to adversely affect** the black-footed ferret.

Canada Lynx

Based on the lack of suitable habitat in the project area it is unlikely that lynx would occur on the ARPA. Therefore, the alternatives would have **no effect** on the Canada lynx.

Preble's Meadow Jumping Mouse

Based upon the known distribution of the Preble's meadow jumping mouse it is extremely unlikely that they would occur on the ARPA. Therefore, the alternatives would have **no effect** on the Preble's meadow jumping mouse.

Bald Eagle

Based upon the analyses of the alternatives, the current and potential status of the species in the project area, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that implementation of the alternatives **may affect** but is **not likely to adversely affect** the bald eagle.

Wyoming Toad

Based upon the known and historic distribution of the Wyoming toad it is extremely unlikely that they would occur on the ARPA. Therefore, the alternatives would have **no effect** on the Wyoming toad.

Blowout Penstemon

Based upon the analyses of the alternatives, the current status of these species, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that implementation of the alternatives **may affect** but is **not likely to adversely affect** blowout penstemon.

Ute ladies'-tresses

Based upon the analyses of the alternatives, the current status of these species, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that implementation of the alternatives **may affect**, but is **not likely to adversely affect** Ute ladies'-tresses.

Colorado Butterfly Plant

Based upon the known distribution of the Colorado butterfly plant it is extremely unlikely that they would occur on the ARPA. Therefore, the alternatives would have **no effect** upon the Colorado butterfly plant.

Colorado River Species

On July 5, 1994, the Service issued a biological opinion determining that the fee for depletions of 100 acre-feet or less would no longer be required. This was based on the premise that the Recovery Program has made sufficient progress to be considered the reasonable and prudent alternative avoiding the likelihood of jeopardy to the endangered fishes and avoiding destruction or adverse modification of their critical habitat by depletions of 100 acre-feet or less. Impacts to the endangered fish species that are downstream of the ARPA in the Colorado River are expected to be less than 100 acre-feet per year, under any of the alternatives.

The Colorado pikeminnow, bonytail, humpback chub, and razorback sucker do not occur on the ARPA and the minimal water depletions to the Colorado River system that may occur would impact these species. Therefore, it is concluded that implementation of the action alternatives is **likely to adversely affect** these fish species.

Platte River Species

The whooping crane, interior least tern, piping plover, Eskimo curlew, pallid sturgeon, and western prairie fringed orchid do not occur on the ARPA and no water depletions to the Platte River system would occur. Therefore, it is concluded that implementation of the Proposed Action and any of the alternatives would have **no effect** upon these species.

References Cited

Archer, D.L., L.R. Kaeding, B.D. Burdick, and C.W. McAda. 1985. A study of the endangered fishes of the upper Colorado River. Final report. Cooperative agreement 14-16-0006-82-959. U.S. Department of the Interior, Fish and Wildlife Service, Grand Junction, CO.

Baxter, G. T., and M. D. Stone. 1992. Amphibians and Reptiles of Wyoming. Wyoming Game and Fish Department, 137pp.

_____. 1995. Fishes of Wyoming. Wyoming Game and Fish Department, 290pp.

Beauvais, G. B. 2000. Preble's Meadow Jumping Mouse *(Zapus hudsonius preblei*). Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming.

Beauvais, G.P., D. Keinath, and J. Ratner. 2001. Habitat mapping and field surveys for lynx (*Lynx Canadensis*) on lands administered by the USDI-Bureau of Land Management in Wyoming. Wyoming Natural Diversity Database, Laramie, Wyoming. 11 pp. plus appendices.

Bennett, J.R. 2002. Yellow-billed cuckoo (*Coccyzus americanus*) – Wyoming State species abstract. Wyoming Natural Diversity Database, Laramie, WY. 3pp.

Biggins, D.B. Miller, B. Oakleaf, A. Farmer, R. Crete, and A. Dood. 1989. A system for evaluating black-footed ferret habitat: report prepared for the interstate coordinating committee. U.S. Department of the Interior, Fish and Wildlife Service; Wyoming Game and Fish Department; and Montana Department of Fish, Wildlife and Parks.

Fagerstone, K.A. 1987. Black-footed ferret, long-tailed weasel, and least weasel. Pages 548-573 *in* M. Novak, J.A. Baker, M.E. Obbard, and B.Mallock, editors. Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario.

Federal Register. 1978. Proposed critical habitat for the whooping crane. 43(160):36588-36590.

Federal Register. 2002. Designation of critical habitat for the northern Great Plains breeding population of the piping plover; final rule. 67(176):57637-57717.

Fertig, W. 2000. Status review of the Ute ladies'-tresses (*Spiranthes diluvialis*) in Wyoming. Report prepared for the Wyoming Cooperative Fish and Wildlife Research Unit, US Fish and Wildlife Service, and Wyoming Game and Fish Department by the Wyoming Natural Diversity Database, Laramie, Wyoming.

_____. 2001. 2000 survey for blowout penstemon (*Penstemon haydenii*) in Wyoming. A report prepared for the Bureau of Land Management Wyoming State Office. Wyoming Natural Diversity Database, University of Wyoming, Laramie.

Gollop, J.B. T.W., Barry, and E.H. Iverses. 1986. Eskimo curlew a vanishing species? Saskatchewan Natural History Society special publication No. 17. Regina Saskatchewan. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/curlew/curlew.htm (Version 16 July 1997).

Hall, E.R. and K.R. Kelson. 1959. The mammals of North America. The Ronald Press Company, New York. 1083pp.

Hillman, C.N. and T.W. Clark. 1980. Mustela nigripes. Mammalian Species No. 126. 3pp.

Minckley, W. L. and J. E. Deacon. 1991. Battle against extinction: native fish management in the American West. University of Arizona Press.

Montana Bald Eagle Working Group. 1990. Bald eagles of the upper Columbia basin: timber management guidelines. USDA-Forest Service, Billings, MT.

NatureServe. 2003. NatureServe explorer: an online encyclopedia of life [web application]. Version 1.8 NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.

NatureServe. 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: September 15, 2004).

Nebraska Game and Parks Commission (NGPC). 2002. The blowout penstemon: an endangered species. http://www.ngp.ngpc.state.us

Payne, R.B. 1997. Family Cuculidae (Cuckoos). Pp. 508 - 607 *in* J. del Hoyo, A. Elliott, and J. Sargatal (eds.). Handbook of the Birds of the World. Vol. 4. Sandgrouse to Cuckoos. Lynx Edicions, Barcelona. 679 pp.

Reeve, A.F., F. Lindzey, and S. Buskirk. 1986. Historic and recent distribution of the lynx in Wyoming. Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, Wyoming. 55 pp.

Swenson, J.E., K.L. Alt, and R.L. Eng. 1986. Ecology of bald eagles in the Greater Yellowstone Ecosystem. Wildlife Monographs 95:1-46.

Upper Colorado River Endangered Fish Recovery Program. 1999. Website of the Upper Colorado River Endangered Fish Recovery Program. http://www.r6.fws.gov/coloradoriver.

U.S. Department of the Interior – Bureau of Land Management (UDSI-BLM). 2005. Rawlins Field Office. Draft Environmental Impact Statement Atlantic Rim Natural Gas Project, Carbon County, Wyoming. Rawlins, WY.

U.S. Department of the Interior - Fish and Wildlife Service (USDI-FWS). 1989. Black-footed ferret survey guidelines for compliance with the Endangered Species Act. U.S. Department of the Interior, Fish and Wildlife Service, Denver, CO and Albuquerque, NM. 15pp.

_____. (USDI-FWS). 1990. Recovery plan for the interior population of the least tern (Sterna Antillarum). Twin Cities, Minnesota. 90 pp.

_____. (USDI-FWS). 1993. Colorado River endangered fishes critical habitat. Draft biological support document. Salt Lake City, Utah.

_____. (USDI-FWS). 2002. Endangered, threatened, proposed, petitioned and candidate species of Wyoming. Wyoming Field Office, Cheyenne, WY.

_____. (USDI-FWS). 2004a. Threatened, endangered, and proposed species which may occur within the Bureau of Land Management, Rawlins Field Office's area of management. March 24, 2004. Fish and Wildlife Service, Cheyenne, Wyoming.

_____. (USDI-FWS). 2004b. Black-footed ferret block clearance letter – February, 2004.

USGS Patuxent Wildlife Research Center. 2004. North American Breeding Bird Survey Internet data set, 15 September 2004 (http://www.pwrc.usgs.gov/bbs/retrieval/).

Valdez, R. A. and G. H. Clemmer. 1982. Life history and prospects for recovery of the humpback and bonytail chub. Pages 109-119 *in* Miller, W.H., H.M. Tyus, and C.A. Carlson, editors. Fishes of the upper Colorado River system: present and future, Bethesda, MD: Western Division, American Fisheries Society.

Valdez, R. A., R. J. Ryel, S. W. Carothers, and D. A. House. 2000. Recovery goals for the humpback chub (*Gila cypha*) of the Colorado River Basin: A supplement to the humpback chub recovery plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

Warren, A. 2002. Range Management Specialist, Rawlins BLM Field Office. Personal communication with Larry E. Bennett, Hayden-Wing Associates, February 11.

Wyoming Game and Fish Department (WGFD). 1991. Wyoming trout stream classification map. Wyoming Game and Fish Department, Biological Services Section, Cheyenne, WY. 1pp.

_____. (WGFD). 1998. Muddy Creek Basin management plan. Wyoming Game and Fish Department, Cheyenne, WY.

_____. (WGFD). 1999. Atlas of birds, mammals, reptiles and amphibians in Wyoming. Wyoming Game and Fish Department, Biological Services Section, Lander, WY. 190pp.

_____. (WGFD). 2003. Wildlife Observation System (WOS) database printout. T12-21N: R88-92W. Wyoming Game and Fish Department, Cheyenne, WY. November 17, 2003.

Wyoming Natural Diversity Database (WYNDD). 2003. Data compilation for T. Olson, for the Atlantic Rim Project Area, completed August 21, 2003. Unpublished report. Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming.

Subj: **OneHanesPlace.com On-Line Order Receipt**
Date: 12/3/2005 8:12:55 A.M. Mountain Standard Time
From: ohp.manager@onehanesplace.com
To: hedley105@aol.com

Your order has been received and is currently being processed.

A detailed order confirmation email will be sent to you after processing has been completed.

Thank you for shopping at www.onehanesplace.com !

Do a friend a favor...forward this e-mail!
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APPENDIX H

BEST MANAGEMENT PRACTICES

Required Best Management Practices
Consolidated Table
Appendix H

These BMPs will be applied under all alternatives as Conditions of Approval where projects conflict with identified resources.

Additional site-specific Conditions of Approval may be implemented at the project level as applicable.

Additional mitigation measures are also identified in:

- Appendix K, Applicant Voluntary Committed Measures
- Appendix B, Reclamation Plan,
- Appendix E, Wildlife Monitoring/Protection Plan
- Appendix J, Best Management Practices for Reducing Non-Point Source Pollution

These mitigation measures are further described in:

- Draft Rawlins Resource Management Plan
- BLM/Forest Service *Surface Operating Standards for Oil & Gas Exploration and Development* ("Gold Book")
- BLM Manual 9113

Paleontology Resources		
Paleontology Resources	Each proposed facility located in areas with known and potential vertebrate paleontological resource significance (Class II Paleontology Condition 1 and 2 areas and Probable Fossil Yield Class 3, 4, and 5 areas) would be surveyed by BLM-approved paleontologist prior to surface disturbance (USDI-BLM 1987b;1990) 2) If paleontological resources are discovered at any time during construction, all construction activities would halt and BLM personnel would be immediately notified. Work would not proceed until paleontological materials are properly evaluated by a qualified paleontologist.	
Cultural Resources		
Cultural sites eligible under criterion D - Physical Site Locations Sites containing or likely to yield important scientific data; Sites associated with Important people or events, unique construction (see Appendix X)	1) Collocate roads and pipelines 2) Data recovery	Wyoming State Protocol - Approved procedures for the implementation of Section 106 NHPA and 36 CFR 800 Criteria for Eligibility are found in 36 CFR 60.4
Cultural sites eligible under criterion A, B, and C, including Historic Trails Visual Setting	1) Collocate roads and pipelines 2) Brush hog all rights-of-way where feasible. 3) No surface disturbance within ¼ mile of the trails or visual horizon whichever is closer. 4) Use low-profile facilities. 5) Paint all surface facilities a color compatible with local environment. 6) Surface all roads with material compatible in color with the local environment.	Wyoming State Protocol - Approved procedures for the implementation of Section 106 NHPA and 36 CFR 800 Criteria for Eligibility are found in 36 CFR 60.4; Special measures should be considered within 2 miles either side of the entire trail corridor, since viewsheds of contributing segments may be affected even if a project is located immediately adjacent to a non-contributing portion.

Native American Sensitive Sites/Traditional Cultural Properties (TCP) Native American Consultation is the first step to identify important mitigation measures to be considered	Determined on a case-by-case basis	Numerous laws and directives including: Native American Graves Protection and Repatriation Act of 1990 (NAGPRA); American Indian Religious Freedom Act of 1978 (AIRFA); Executive Order 13007 Native American sensitive sites may or may not be eligible for the National Register. Mitigation measures are considered on a site specific basis.
Fluid Minerals		
SMAs water resources, visual resources, wildlife, vegetation, fisheries	1) Require transportation planning map in a GIS compatible format with all operator coordination and input, to minimize duplication of roads, compressor stations, pipelines and other facilities.	
Reducing Impacts from fluid mineral construction, operation, and reclamation	1) Directional drilling 2) Drill multiple wells from a single pad 3) Transportation planning (to reduce road density and traffic volumes) 4) Remote well monitoring 5) Pipe produced liquids to centralized tank batteries off-site to reduce traffic to individual wells 6) Submersible pumps 7) Below ground well heads 8) Bus workers to reduce traffic volume 9) Flareless well completions 10) Bury distribution power lines and flowlines in or adjacent to access roads. 11) Design and construction of all new roads to a safe and appropriate standard, "no higher than necessary," to accommodate their intended use 12) Reuse of old roads or pads 13) Interim reclamation of well locations and access roads soon after well is put into production, as described in the Reclamation Plan, Appendix B. 14) Avoid facility placement on steep slopes, ridge tops, and hill tops. 15) All production facilities installed on location that have the potential to leak or spill oil, glycol, produced water, or other fluid, shall be placed within an appropriate containment or diversionary structure.	BMPs; Reclamation Plan – Appendix B

	16) On-site bio-remediation of oil field wastes and spills 17) Remove trash, junk, waste and other materials not in current use. 18) All existing and proposed roads shall be brought up to BLM minimum standards as found in BLM Manual 9113.	
	Reclamation Plan	
Appendix B – Reclamation Plan Control and minimize surface run-off, erosion, and sedimentation; invasive weed control; native vegetation and habitat protection/restoration; visual resource management	See Appendix B – Reclamation Plan for complete, specific reclamation guidance	
	Vegetation Resources	
Aspen, Juniper Woodland, Serviceberry, Mountain Mahogany vegetation communities.	1) Avoidance areas. Plans should be submitted and approved by BLM for surface disturbance in these areas. Only those areas that cannot be avoided could be approved.	Plant communities which failed to meet Rangeland Health Standard #3 in 2001 assessment. These communities are high value, low occurrence, and present reclamation difficulties
Control of invasive weeds	Weeds shall be controlled on project disturbed areas and native areas infested as a direct result of the project. The control methods shall be in accordance with guidelines established by the EPA, BLM, state and local authorities. Prior to the use of pesticides, the operator will obtain written approval from the BLM Authorized Officer (meaning an approved pesticide use proposal form).	Wyoming Weed and Pest Control Act, 1973 & Wyoming Weed and Pest Special Management Program, Title 11, Chapter 5. Executive Order 13112
Protection of study areas.	Avoid any disturbance to monitoring sites.	Rangeland Health Standards, 43CFR 4180.1

Visual Resource Management		
VRM Management Class III areas visible from State, County and BLM roads in Viewshed	1) Gravel of road surfacing shall be similar color to adjacent dominant soil colors. 2) Avoid locating pads in areas visible from primary roads. 3) Avoid locating facilities on or near ridgelines - use subsurface or low-profile facilities to prevent protrusion above horizon line when viewed from any primary road. 4) Avoid routing well access roads directly from State, County, or BLM roads. 5) Co-locate wells when possible. 6) Locate facilities far enough from the cut and fill slopes to facilitate recontouring for interim reclamation. 7) Do not locate wells adjacent to prominent features such as rock outcrops. 8) Repeat elements of form, line, color, and texture to blend facilities and access roads with the surrounding landscape 9) Complete annual transportation plan for entire area before beginning construction - make layout that will minimize disturbance and visual impact. 10) Design and construct all new roads to a safe and appropriate standard, "no higher than necessary" to accommodate their intended use. 11) Locate roads far enough off the back of ridgelines so they aren't visible from State, County or BLM roads. 12) Use remote monitoring to reduce traffic and road requirements. 13) Remove unused equipment, trash and junk immediately. 14) Reclaim unnecessary access roads as soon as possible. 15) All above-ground structures, production equipment, tanks, transformers, insulators, not subject to safety requirements shall be painted to blend with the natural color of the landscape. The paint used shall be a non-reflective "Standard Environmental Color" approved by the BLM VRM specialist.	VRM BMPs for Fluid Minerals, VRM H-8400-1, Land Use Planning H-1601-1
Slopes < 5% in VRM Management Class III areas visible from State, county and BLM roads Minimizing road construction methods will reduce visual impacts by reducing vegetative removal and soil exposure.	1) Do not create unnecessary cut and fill. Design and construct all new roads to a safe and appropriate standard, "no higher than necessary" to accommodate their intended use.	VRM BMPs for Fluid Minerals, VRM H-8400-1, Land Use Planning H-1601-1

Water and Soil Management		
Non-Point Source Pollution	See Appendix J, Best Management Practices for Non-Point Source Pollution	Clean Water Act Section 303(e) and 40 CFR 130.5
Water Management Plan as part of the Annual Work Plan submittal in April	1) The Atlantic Rim operator responsible for new development around existing pods will submit a Water Management Plan as part of the Annual Workplan submittal in April. This plan will have the following information: o 12-digit HUC number and name o All digital and other information required by the Annual Workplan o Surface water assessment of current road network in the area including future plans for maintenance. o Average daily water production per well at current pod wells. o Average daily injection volumes of current injection wells, by well. o Unused injection well capacity o Estimated water production from proposed wells o Location, name and estimated capacity of new injection wells o Special Protection Measure for each well location, if appliciable o Any water quality sampling results	Monitoring, planning and compliance for the success of the project
Surface disturbance on slopes >25% as identified from the 30 meter DEM data.	1) Plans should be submitted and approved by BLM for surface disturbance in these areas. Only those areas that cannot be avoided could be approved.	Wyoming Standard Mitigation Guidelines
Drainage Crossings	1) Culverts or low-water crossings would be installed for all ephemeral and intermittent drainage crossings. All drainage crossing structures and culverts would be designed to pass at a minimum the 25-year discharge events, or as otherwise directed by the BLM. 2) The design of channel crossings will minimize changes in channel geometry and subsequent changes in flow hydraulics. Disturbed channel beds will be regarded to the original geometric configuration with the same or very similar bed material. 3) Construction of drainage crossings will be limited to no-flow periods or low-flow periods. 4) Channel crossings for buried pipelines will be constructed such that the pipe is buried a minimum of four feet below the channel bottom.	Wyoming Standard Mitigation Guidelines
Reducing surface runoff and erosion	1) Adequate drainage control devices and measures would be included in the road design and maintenance (e.g., road berms and drainage ditches, diversion ditches, cross drains, culverts, out-sloping, and energy dissipaters) at sufficient intervals and intensities to adequately control and direct surface runoff above, below, and within the road environment to avoid concentrated flows. 2) Locations for these features will be proposed in Annual APD approval	Wyoming Standard Mitigation Guidelines

	master plans submitted by the operator and will be identified specifically in construction plans after BLM onsites. 3) Erosion control devices would also be used in conjunction with the surface runoff and drainage control devices, such as temporary barriers, ditch blocks, erosion stops, mattes, mulches, and vegetative covers. A revegetation program would be implemented as soon as possible to re-establish the soil protection afforded by a vegetal cover.	
Well Inventories Water developments associated with groundwater	1) All potentially affected landowners having properly permitted water wells with the Wyoming State Engineer's Office within each proposed well's circle of influence (1/2 mile radius) were offered a Water Well Agreement; and if a water well agreement is not reached with the landowner, the responsible Atlantic Rim Operator will mitigate the impacts in accordance with State of Wyoming water laws. Some examples of mitigation would be drilling an additional supply well or provide CBNG water as an offset.	Potential Impact Mitigation – Note that this is situation is very unlikely to occur, but important to address if it does occur.
Interim reclamation of unused areas.	1) The Operators propose to completely reclaim all disturbed areas not needed for production activities including 1) pipeline ROW, 2) portion of road ROW not needed in the function of the road, and 3) the portion of the drill pad not needed during production. Reclamation would generally include 1) complete cleanup of the disturbed areas; 2) the topography would be restored to contours that existed prior to construction; 3) ripping of disturbed areas to a depth of 12 to 18 inches; 4) topsoil or suitable plant growth material would be replaced over all disturbed surfaces; and 5) seeding of reclaimed areas with the seed mixture prescribed in the Surface Use Plan or Plan of Development for the proposed Action, and 6) mulching or soil amendments, if considered necessary by the BLM officer.	Reduce long-term disturbance by improving reclamation success.
Water Used for Construction, Maintenance, and Drilling Activities	1) All water used for drilling, completion and testing activities will come from existing CBNG wells or re-used from other drilling sites, subject to State permitting. 2) All water used for construction, dust abatement or hydrostatic testing will come from existing CBNG wells or sources with sufficient quantities and through appropriation permits approved by the State of Wyoming. Surface water and shallow groundwater sources would only be located in the Colorado River Basin and has been consulted on with the Fish and Wildlife Service (See Appendix x: Biological Opinion). Under no circumstances are these methods to be used for water disposal, only volumes appropriate for the use would be approved. 3) Hydrostatic test water will be discharged in a controlled manner onto an energy dissipater and within existing ROWs. The water is to be discharged onto undisturbed land that has vegetative cover and with energy dissipation such as using a rock armored apron or gated pipe. Prior to discharge, water	CBNG water is generally of good enough water quality in this area to be used for these purposes. Waters from the producing coal seams has been shown to be geographically isolated from most water sources (see 4.4). These are proper beneficial uses with the States approval that would not change impacts if used in volumes commiserate with the water needs. These methods are not intended to help with

	should be tested and treated or filtered if necessary to reduce pollutant levels or to settle out suspended particles if necessary. Coordinate all discharge to test water with the SEO, WDEQ and the BLM.	water disposal needs for the project, since they are generally of such low volumes
	Range Management	
Range Improvements	1) Employ prevention measures to avoid damaging fences, gates, and cattleguards. 2) Report and correct any damage that occurs to rangeland improvement projects. 3) Prior to drilling, upgrade cattleguards and gates width and load bearing requirements to meet BLM Road Standards (BLM Manual 9113).	Protect function and value of range improvements
Reduce danger to livestock from potential hazardous wastes	1) For the protection of livestock, all pits and open cellars shall be fenced. Fencing shall be in accordance with BLM specifications.	
	Wildlife	
Appendix F Wildlife Monitoring/Protection Plan Wildlife Monitoring/Protection	For complete list of wildlife protection measures, see Appendix E	
Big Game crucial winter range	1) Directional drilling 2) Drill multiple wells from a single pad 3) Remote well monitoring 4) Transportation planning (to reduce road density and traffic volumes) 5) Cluster development 6) Compensation mitigation 7) Seasonal restriction of public vehicular access.	BMP's
Greater sage-grouse and Columbian sharp-tailed grouse habitat	1) Directional drilling 2) Drilling of multiple wells from a single pad 3) Seasonal restriction of public vehicular access 4) Noise reduction techniques and designs 5) Use of low profile well facilities and tanks 6) Burying of power lines to avoid use of poles and other tall structures 7) Transportation planning to align roads out of sight and sound of leks, and to schedule traffic to avoid greater sage-grouse and Columbian sharp-tailed grouse activity periods 8) Design of roads to minimum safe standard for intended use 9) Partial reclamation of resource roads needed for project construction to lower standards necessary for maintenance operations	BMP's

Wildlife Habitat	1) Seasonal restriction of public vehicular access 2) Implementation of the Wyoming Bird Conservation Plan from Wyoming Partners in Flight.	BMP's
Potential hazards to wildlife	1) For the protection of wildlife, all pits and open cellars shall be fenced. Fencing shall be in accordance with BLM specifications. Netting shall be placed over all open production pits to eliminate any hazard to migratory birds or other wildlife. Netting is also required over reserve pits which have been identified as containing oil or hazardous substances (CERCLA Section 101(14)) as determined by visual observation or testing. The mesh diameter shall be no larger than one inch. 2) Cover vent pipes to prevent bats or small birds from being trapped.	
Atlantic Rim mule deer study, Game & Fish Data Disruption of mule deer migration corridors.	1) NSO narrow migration corridor (to be determined following data collection and analysis from Mule Deer Study). 2) Avoid surface disturbance within identified migration corridors.	Minimum programmatic standards recommended by the Wyoming Game and Fish Department to sustain wildlife habitats affected by oil and gas development (WGFD 2004)
Reduce incidental loss of wildlife	1) Inform all project employees of applicable wildlife laws and penalties associated with unlawful take and harassment. 2) Require that regular drivers undergo training describing the types of wildlife in the area that are susceptible to vehicular collisions, the circumstances under which such collisions are likely to occur, and the measures that can be employed to minimize them.	

APPENDIX I

CULTURAL RESOURCES MANAGEMENT

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CULTURAL RESOURCES MANAGEMENT

Program Objectives

The BLM has developed a cultural resources program designed to inventory, evaluate, and manage cultural resources on BLM-administered public land and in areas of BLM responsibility. The BLM management of cultural resources (archaeological, historic, and socio-cultural properties) is in accordance with the provisions of the National Historic Preservation Act (NHPA) of 1966, as amended, and other applicable legislation.

Identification of Cultural Resources

The BLM requires cultural resource inventories for actions involving public lands and/or federal mineral estate that include surface disturbance as a part of the action. Three classes of inventory have been established; Class III is the most intensive and the most often required for areas that have not been subjected to previous inventories or have been subjected to complete surface disturbance in the past.

Class I inventories are completed with the use of existing data from cultural resource inventory files maintained by both the BLM and the Wyoming State Historic Preservation Office (SHPO). Class I inventories serve to identify known properties and are used to determine if more intensive inventory of specific areas is appropriate. This determination is made in consultation with the Wyoming SHPO and often results in the completion of Class II or Class III inventories.

Class II inventories are statistically based sample surveys designed to aid in characterizing the probable density, diversity, and distribution of cultural properties in the area, to develop and test predictive models, and to answer appropriate research questions. Within individual sample units, survey aims, methods, and intensity are the same as those applied in Class III survey. Class II survey may be conducted in several phases, using different sample designs, to improve statistical reliability.

Class III intensive field surveys are conducted by professional archaeologists thorough pedestrian survey of an entire target area. The intent of a Class III inventory is to locate and record all historic properties and is consistent with standards in the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44716). Class III inventories conform to the prevailing professional survey standards for the region involved, provided that the regional standards meet or exceed the Secretary's Standards and Guidelines. Because Class III survey is designed to produce a total inventory of the cultural properties observable within the target area, once it has been completed no further survey work should be needed in the target area as long as the current standards are met. Areas with a high probability of containing buried cultural materials or known cultural materials may require additional work of professional monitoring and/or data recovery excavations. Areas that require additional work are analyzed on a case-by-case basis, depending on the proposed action and the types of cultural resources present in the project area.

Evaluation of Cultural Resource Sites

The BLM evaluates the significance of cultural resources identified during inventory in consultation with the Wyoming SHPO to determine if the resources are eligible for inclusion in the National Register of Historic Places (NRHP). Cultural resource properties may be

considered eligible for listing on the National Register if they meet one or more of the following criteria:

- Criterion A: An historic property is associated with an event or events that have made a significant contribution to the broad patterns of America's History.
- Criterion B: An historic property is associated with the lives of persons significant to our past.
- Criterion C: An historic property embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic value or represents a significant and distinguishable entity whose components may lack individual distinction.
- Criterion D: An historic property has yielded or may be likely to yield information important in prehistory or history.

Those sites eligible under Criteria A, B, or C require case-by-case consultation in which the Wyoming SHPO has 30 days to reply. According to a Programmatic Agreement between the Wyoming BLM and the Wyoming SHPO, the BLM has implied concurrence for determining eligibility of sites under Criterion D of the NHPA.

- To facilitate evaluation of cultural resource values in Wyoming, the BLM has devised guidelines for determining the eligibility of archaeological and historical sites and historic trails (BLM Manual 8110.32). The guidelines supplement the National Register criteria for evaluation (36 CFR 60.4) and provide consistency across the state. Application of the guidelines ensures that significant cultural resources are recognized and managed accordingly.

Properties that encompass large areas can be deemed to have contributing and non-contributing portions. Contributing portions are seen to retain integrity of the values for which the property is considered eligible for the NRHP. Non-contributing portions are identified portions of the property which are not deemed to retain the integrity of values which would render the property eligible for the NRHP. The determination of contributing versus non-contributing portions of an eligible property can be made at any time after adequate evaluation has been conducted.

The historic Cherokee Trail is considered eligible for the National Register under Criterion A. However, some portions of the trails no longer retain the aspects of integrity necessary for eligibility. As there have been no encompassing inventories of the entire trail within the RMPPA, portions of the trail are evaluated to determine if they contribute to the eligibility of the property on a case-by-case basis. Trail segments are evaluated pursuant to the National Register criteria of integrity (location, design, setting, materials, workmanship, feeling, and association). If a predominance of criteria are met, the segment will be considered contributing to the properties' overall NRHP eligibility.

STANDARD PROTECTIVE MEASURES

Description

Within the framework described above, the BLM has developed protective measures to minimize adverse effects on significant cultural resource values.

Protective measures are used in response to the actions of BLM programs involving surface disturbance. These measures include cultural resource inventories, evaluation of cultural resources located during inventory, and mitigation of potential adverse impacts on significant cultural resources. Mitigation may include avoidance, data recovery (including excavation), or other protective measures. Avoidance is the primary and preferred mitigative measure used to protect cultural resources. Consultation with the Wyoming SHPO and the Advisory Council on Historic Preservation is required when surface-disturbing actions are expected to adversely affect properties eligible for the National Register. An adverse effect to an historic property is defined in 36 CFR 800.5(1)..

Although Class III inventories are completed before any surface disturbance can begin, the BLM's opportunity to preserve significant cultural resource values in place can be precluded if cultural properties are not identified prior to initiation of an action. In cases such as this, mitigative actions such as data recovery would be implemented.

For historic trails such as the Cherokee Trail, protection measures would be carried out similarly to other historic properties if any project were found to be located within ¼ mile of a contributing portion of the historic trail. When a proposed project is outside of the ¼ mile buffer of the trail, but found to be within the two-mile viewshed that contributes to NRHP eligibility, analyses of potential impacts to the trails are conducted through viewshed analyses, on-site inspection, and photo inspection. Mitigation measures used to ensure that the contributing viewshed of historic trails are not adversely affected include decreasing the height of well tanks, using paint and topography to blend well locations into the background, mowing and reseeding pipeline corridors, and using materials that match the existing environment to construct access roads.

APPENDIX J

BEST MANAGEMENT PRACTICES FOR REDUCING NON-POINT SOURCE POLLUTION

APPENDIX J

BEST MANAGEMENT PRACTICES FOR REDUCING NON-POINT SOURCE POLLUTION

This appendix describes bested management practices utilized to mitigate adverse effects caused by surface disturbing activities that can contribute to non-point pollution. It should be noted, there are multiple volumes of references for BMPs developed by government and nongovernmental agencies to reduce non-point sources of pollution. Many of these documents contain specific practices and design criteria, the State of Wyoming DEQ publishes general BMPs for Wyoming, (http://deq.state.wy.us/wqd/watershed.asp#non).

Best Management Practices (BMPs) have been developed through experience working with disturbances in the Rawlins Field Office from BLM approved actions and should be used in most cases along with Wyoming BLM Standard Mitigation Guidelines for Surface-Disturbing and Disruptive Activities (Appendix 1). These practices are not stipulations but represent practices that in most cases will serve to improve the design and reduce the environmental impact of proposed BLM management actions in the RMPPA. Operators are encouraged to review these practices, incorporate them where appropriate, and where possible develop better methods for achieving the same goals.

The purpose of this section is not to attempt to select certain practices or designs and require that only those are used. It is not possible to evaluate all the known practices and make determinations as to which are "best", nor is it advisable. What is best must be determined as the result of a site specific investigation of the problem to be solved. What the RFO hopes to accomplish with this section of the appendix is to prescribe basic construction techniques that could be used regardless of project design or purpose.

Section 303(e) of the Clean Water Act and 40 CFR 130.5 require States to maintain a "Water Quality Management Continuing Planning Process." The process must establish procedures for adoption and appeals which, among other items, address BMPs. BMPs are advisory rather than regulatory. They are a key element in a State Nonpoint Source Management Plan, with which the Federal Government must comply under Executive Orders 12088 and 12372, and Clean Water Act Sections 319(k) and 301(k). The practices described in this document are designed to meet the intent of the State of Wyoming's BMPs for BLM approved activities. The reader is encouraged to review the State of Wyoming lists of BMPs which have been developed in response to the Clean Water Act and address silviculture, grazing and hydrology, and a policy statement in lieu of BMPs for minerals and oil and gas. (http://deq.state.wy.us/wqd/watershed.asp#non

MANAGEMENT PLANNING PROCESS

Standard practices or BMPs may develop through the National Environmental Policy Act (NEPA) process into stipulations prior to lease or grant issuance, or they may serve as a basis for Conditions of Approval (COA). If these practices (or newly developed techniques) are already incorporated into plans for development submitted by a permittee, such plans may be approved. BLM considers all project proposals; however it is the burden of the applicant to describe the design and construction techniques planned. If a project's design, scheduling, and construction techniques can mitigate environmental concerns, construction may be allowed without COAs.

As directed by the Federal Land Policy and Management Act and bureau policy, the BLM has developed a three tiered resource management planning process to make land use planning decisions (see Appendix 21: Adaptive Management Plan). These tiers are policy, resource management plans, and activity plans.

Areas of accelerated soil erosion, poor or unstable soils, eroding stream channels, and threatened or impaired stream reaches for water quality (see Appendix 18: Water Quality and Depletions) can be identified as issues during the resource management plan tier of the process or through stakeholder groups with local organizations on listed water bodies. Soil and water conservation practices are addressed in a general fashion during the land use planning tier and in site-specific detail during the activity planning and implementation tier of the process.

The Bureau's nonpoint source strategy is to continue to:

- Provide cooperation and assistance to state agencies and conservation districts in the management of the public lands to reduce nonpoint source pollution sources.

- Incorporate water quality impacts, including nonpoint sources, into land management actions planned and implemented by the bureau and identify and address nonpoint source water quality issues in bureau activity plans for specific projects.

- Provide personnel and resources to identify nonpoint source pollution and control techniques through coordinated research efforts and the implementation of BMPs.

- Proactively implement program practices in conducting land use and land management activities to reduce or avoid water quality impacts and to improve water quality as necessary to meet management objectives and regulatory requirements.

To protect water quality from nonpoint source pollution, as applied by the RFO on BLM lands, the BMP program consists of: 1) defining practices, based on the best information available, that are expected to protect water quality; 2) monitoring to ensure the practices are applied; 3) monitoring to determine the effectiveness of practices; 4) mitigation to address unforeseen problems after the activity begins; and, 5) adjustment of design specifications of BMPs for future activities, where appropriate (See Appendix 21: Adaptive Management Plan). Typically a site and/or project specific NEPA analysis will define practices and specify monitoring needs if applicable. The project proponent would then be responsible to mitigate unforeseen problems as they arise, typically with BLM review, and the BLM would be responsible to make adjustments to the process or methods used and as needed after each project.

The Wyoming BLM policy on reclamation assumes that an area can and shall be ultimately reclaimed, and requires that every surface disturbance on public lands receive attention for short-term stabilization and long-term reclamation. Mitigation measures or BMPs reduce, to the extent possible, the amount of reclamation that ultimately must take place. The permit or authorization is the means provided for ensuring that mitigation measures or Conditions of Approval (COA) are implemented. Compliance inspections during operations ensure that mitigation, COA and/or stipulations are being followed.

Watershed Protection

The entire land surface should be considered for nonpoint pollution control, with specific attention given to areas where the flow of water is concentrated naturally or due to construction

(including roads, well pads, drainage ditches and steam channels). Stream sediment, phosphate, and salinity load would be reduced where possible.

The following standard practices are to protect watershed function:

- Construction of ephemeral, intermittent, and perennial streams crossings associated with road and utility line construction would generally be restricted until after spring runoff and until normal flows are established.

- The inner gorge of intermittent and ephemeral drainages should be burned in such a manner as to leave unburned patches of vegetation. The use of herbicides for vegetative manipulation should proceed with great care when in the proximity of willows, cottonwoods, or aspens, so as not to damage such stands unless the prescription actually calls for such removal.

- Herbicide loading sites would be located at least 500 feet from live water, floodplains, riparian areas, and all special status plant locations.

- Vegetative buffer strips should be maintained between developed recreational facilities and live water. Prior to installing toilet facilities associated with recreation, ground water protection should be provided for.

- Installation of instream structures for fisheries, watershed, or irrigation enhancement should be completely engineered if the high flow for the stream exceeds 10 CFS (cubic feet/second).

- To minimize long-term surface disturbances within the vegetated sand dunes or other sensitive soils, options such as directional drilling, smaller well pads, and surface lines should be considered. To enhance reclamation success through surface stability, techniques to reduce wind erosion should be considered. These methods could include snow fences, soil tackifiers, and erosion control matting.

Floodplain protection is required by E.O.11988., in reference to federal real property and facilities. It states that facilities are to be located in a floodplain (i.e., when there is no practicable alterative), agencies shall ensure that flood protection measures are applied to new construction, or the agency can rehabilitate existing structures; elevate structures rather than fill the land; provide flood height potential markings on facilities to be used by the public; and, when the property is proposed for lease, easement, right of way, or disposal, the agency must attach restriction on uses in the conveyance or withhold from such conveyance.

For the most part standard practices to protect water quality and floodplains are to avoid surface disturbing activity in identified 100-yr floodplains, within 500 ft. of perennial waters and wetland/riparian and 100 ft. from the inner gorge of ephemeral channels. These buffers provide an opportunity for concentrated flows to be dispersed before they reach a water body and often preclude construction in riparian zones, except for linear features. Surface disturbing activities and permanent facilities placement avoid these buffers unless it is determined through site-specific analysis, that there is no practical alternative. If such a circumstance exists, then all practical measures to mitigate possible harm to the above areas are employed. These mitigating measures would be determined case by case and may include (but are not limited to) diking, lining, screening, mulching, terracing, and diversions.

Floodplains by their very nature are unsafe locations for permanent structures. With an inundation of flood waters, soils disturbed by construction could experience a rate of erosion greater than undisturbed sites. There is an additional concern over the potential for flood waters to aid in the dispersal of hazardous materials that may be stored within permanent structures. Therefore, floodplains should have no permanent structures constructed within their boundaries unless it can be demonstrated on a case-by-case basis that there is no physically practical alternative. In cases where identified 100-yr floodplain construction is approved, additional constraints would be applied through COAs.

Soils

Current objectives focus on soil conservation planning for surface disturbance actions. Soil conservation should be addressed during the initial phase of any surface disturbing action, thereby maintaining soil productivity and stability levels through the use of existing guidelines and techniques. Some areas may require more thorough soil management practices than others; however this is dependent on the type and duration of the action and the effect on site-specific soil characteristics.

Management of the soil resource would continue to be based on the following factors: (1) Evaluation and interpretation of soils in relation to project design and development, (2) Identification and inventory of soils for baseline data (soil surveys), and (3) Identification and implementation of methods to reduce accelerated erosion of top soil.

Evaluation and interpretation involves identification of soil properties that would influence their use, and recommendations for development while minimizing soil loss. Projects would be examined on a site-specific basis, evaluating the potential for soil loss and the compatibility of soil properties with project design. Stipulations and mitigating measures are provided on a case-by-case basis to ensure soil conservation and practical management. Projects requiring soil interpretations include construction of linear right-of-way facilities (i.e., pipelines, roads, railroads, and power transmission lines); construction of water impoundments; rangeland manipulation through fire or mechanical treatments; construction of plant site facilities, pump stations, well pads, and associated disturbances; and reclamation projects.

Soil surveys are designed to update general soils information and provide data to those areas lacking soil inventories. Allotments and areas impacted by oil and gas projects will receive priority in the soil survey process and BLM will encourage and participate in soil surveys as opportunities arise.

Before a surface disturbing activity is authorized, topsoil depth would be determined. The amount of topsoil to be removed, along with topsoil placement areas, would be specified in the authorization. The uniform distribution of topsoil over the area to be reclaimed would be required unless conditions warrant a varying depth. On large surface disturbing projects (e.g., gas processing plants), topsoil would be stockpiled and seeded to reduce erosion. Where feasible, topsoil stockpiles would be designed to maximize surface area to reduce impacts to soil microorganisms. Stockpiles remaining less than two years are best for soil microorganism survival and native seed viability. It is recommended that stockpiles be no more than 3 to 4 feet high. Areas used for spoil storage would be stripped of topsoil before spoil placement. The replacement of topsoil after spoil removal would be required.

Some examples of standards applied throughout the Field Office area based on soil management criteria are as follows:

- Individual road closures due to saturated soil conditions when soil resource damage would occur due to wheel rutting or compaction of wet soils
- Salvage and subsequent replacement of topsoil whenever possible on surface disturbing activities
- Avoiding disturbance on unstable slopes or slopes greater than 25 percent.
- Identification of critical erosion condition areas during site-specific project analysis, and activity plan development for the purpose of avoidance and special management.
- Temporary disturbances which do not require major excavation (e.g., small pipelines and communication lines) may be stripped of vegetation to ground level using mechanical treatment, leaving topsoil intact and root mass relatively undisturbed.

Uncontrolled settlement of clay particles does not provide a consistently adequate seal on a stock pond or reservoir. Compaction or permeability testing should be used to determine pit characteristics in conjunction with BLM engineers. If clay soils are used as stock pond lining, they should have a liquid limit greater than 30 and a Plasticity Index of at least 20. Assuming that bentonite would sufficiently seal a pit is not a good procedure, because the bentonite must be adequately compacted, with uniform coverage and density. If not, a chemical reaction may occur between the bentonite and native soil partilces. Bentonite is also subject to cracking if it is not designed properly and the layer may be penetrated by hooves if not buried sufficiently.

In general, emphasis should continue to be placed on the reduction of soil erosion and sediment. Of particular importance would be those areas with saline soils or those areas with highly erodible geology and soils.

Air-Born Dust and Air Quality

BLM actions must comply with all applicable air quality laws, regulations, and standards. As projects are proposed that include possible major sources of air pollutant emissions, air quality protection-related stipulations are added to BLM permits and rights-of-way grants. In addition BLM coordinates with the Wyoming Department of Environmental Quality, Air Quality Division, during the process of analysis. This coordination results in technical review of applications for permits and/or identification of additional stipulations to be applied to these permits.

Dust Control: The following standard practices limit the emission of fugitive dust:

- The use of water or chemicals to control dust in the demolition of structures, in construction operations, grading of roads, or clearing of land.
- The use of water for dust abatement may be considered on a case-by-case basis. The water should meet state standards for this use and be permitted by the State of Wyoming. Only the water needed for abating dust should be applied; this method should not be used as a water disposal option under any circumstances. There should be no traces of oil or solvents in water used for dust abatement.
- All weather surfacing of roads using gravel or asphalt paving and the application of water or suitable chemicals to keep dust in place on roads or materials stockpiles.
- Appropriate road design including shape, drainage and surface material to protect road bed from being eroded.

Prescribed Fire Emissions: The emissions that may be created directly by BLM activities are mitigated. Prescribed fires are conducted to reduce emissions by burning only at appropriate fuel moistures and wind speeds (among other factors), which reduce as much as possible the smoke created in locations near populated areas. All BLM activities that may potentially cause undesirable air quality impacts are also coordinated with the Wyoming DEQ-AQD. Permits to conduct these activities are secured (where necessary) before the activity begins, to ensure compliance with all federal, state, and local air quality laws.

Pipelines and Communication Lines

Existing roads would be used for access to utility lines where possible to minimize surface disturbances. Where possible, clearing of pipeline and communication line rights-of-way would be accomplished with the least degree of disturbance to topsoil. Where topsoil removal is necessary, it would be stockpiled (wind-rowed) and respread over the disturbance after construction and backfilling are completed. Vegetation removed from the right-of-way would also be required to be respread to provide protection, nutrient recycling, and a seed source.

On ditches exceeding 36 inches in width, 6 to 12 inches of surface soil should be salvaged where possible from disturbed sites. When pipelines and communication lines are buried, there should be at least 48 inches of backfill on top of the pipe. Backfill should not extend above the original ground level after the fill has settled. Bladed surface materials would be respread on the cleared route once construction is completed.

To promote soil stability, the compaction of backfill over the trench would be required (not to extend above the original ground level after the fill has settled). Water bars, mulching, and terracing would be required as needed to minimize erosion. Instream protection structures (e.g., drop structures) may be required in drainages crossed by a pipeline to prevent erosion.

For communication lines or other small lines like plastic water lines that do not require trenching, a ditch witch or similar trenching machine should be used to reduce disturbance and the need for reclamation.

Grazing BMPs

Proper grazing is the practice of managing forage harvest by all grazing animals including domestic livestock at a sustainable yield that does not accelerate erosion and sedimentation above acceptable levels for the receiving waters. Proper grazing will maintain or increase plant cover including residue, which should in turn slow down or reduce runoff and increase water infiltration. Allotment management plans, conservation plans or similar documents should contain a list of the BMPs most appropriate for the area. Management plans must be developed with reasonable goals and objectives and progress toward goals and objectives must be monitored. Monitoring must include measures of actual changes in resource conditions as well as measurements of completion of objectives and tasks. BMPs have been developed for Domestic Animals, Wildlife (Big Game Animals), Wildlife (Small Game and Nongame Animals), Wild Horses, Proper Grazing - Riparian and Wetland Areas, Fencing , Livestock Herding, Access Roads, Water Development - Instream and Offstream, Land Treatment – Biological, Land Treatment – Mechanical, Weed and Pest Management, and Windbreaks (Wyoming DEQ, 1997).

BLM Healthy Rangelands Standards and Guidelines (Appendix 14) will be used for assessment of water quality issues associated with BLM activities. Allotments are evaluated based on these criteria and BMPs can be developed within Allotment Plans to improve or maintain these standards. Included in these assessments are an evaluation of water quality, wetland/riparian areas, and upland conditions among other factors. These serve as the guidance and goals for Allotment Plans and would be used to evaluate monitoring and apply the Adaptive Management Plan (Appendix 21). These BMPs are developed at the site specific level of planning to account for local constraints and conditions.

Many grazing systems exist. There is no single system for all vegetation types. The proper system or combination of systems must be selected to fit any given site. Consideration must be given to season of use, soil type, precipitation, range condition, stocking rates, type of livestock, plant growth rates, and ecological site potential. The numbers of all grazing animals should be maintained in balance with their habitat. Options for developing a grazing management system at a particular location include but are not limited to:

- Livestock stocking rates
- Wild horse and/or wildlife densities
- Livestock, wild horse or wildlife distribution
- Timing and duration of each rest (including complete rest) and grazing period
- Livestock kind and class
- Forage allocation for livestock, wildlife and wild horses
- Water developments to improve distribution
- Salt/mineral supplements (these should be located away from water sources)
- Livestock access control
- Rehabilitation measures

Well Pads and Facilities

Site specific reclamation procedures would be developed in each Application for Permit to Drill (APD), Right-of-way (ROW) application, or Sundry Notice submitted to the BLM for review and approval prior to the authorization of surface-disturbing activities, mitigation measures can be applied.

Both produced water and reserve pits should be constructed to ensure protection of surface and groundwater. The review to determine the need for installation of lining material should be done on a case-by-case basis and consider soil permeability, water quality, and depth to ground water. Oil-based muds would be allowed in closed drilling systems. Drill cuttings and any remaining oil- based drilling fluids would be disposed in an environmentally acceptable manner. Pits should be lined if there is not sufficient clay in the building material to prevent infiltration of fluids into shallow groundwater.

Reserve pits would not be located in areas where ground water is less than 50 feet from the surface and soil permeability is greater than 10^{-7}cm/hr. If ground water is encountered during

the setting of the conductor, a closed drilling system will be used. Pits would be fenced as specified in individual authorizations. Any pits with harmful fluids in them shall be maintained in a manner that would prevent migratory bird mortality. Drilling pits are exempt from hazardous waste regulations as long as they are covered with 5 feet of soil after use.

Abandoned sites must be satisfactorily rehabilitated in accordance with a plan approved by BLM (see restoration section). Soil samples may be analyzed to determine reclamation potential, appropriate reseeding species, and nutrient deficits. Tests may include pH, mechanical analysis, electrical conductivity, and sodium content. Terraces or elongated water breaks would be constructed after slope reduction. Disturbances should be reclaimed or managed for zero runoff from the location until the area is stabilized. All excavations and pits should be closed by backfilling and contouring to conform to surrounding terrain. On well pads and larger locations, the surface use plan would include objectives for successful reclamation, including soil stabilization, plant community composition, and desired vegetation density and diversity.

On producing locations, operators would be required to reduce slopes to original contours (not to exceed 3:1 slopes). Areas not used for production purposes should be backfilled and blended into the surrounding terrain and reseeded. Erosion control measures should be installed, as they would be required after slope reduction. Facilities would be required to approach zero runoff from the location to avoid contamination and water quality degradation downstream. Mulching, erosion control measures, and fertilization may be required to achieve acceptable stabilization.

Any produced water pit or drilling fluids pit that shows indications of containing hazardous wastes would be tested for the Toxicity Characteristic Leaching Procedure constituents. If analysis proves positive, the fluids would be disposed of in an approved manner. The cost of the testing and disposal would be borne by the potentially responsible party.

No surface disturbance is recommended on slopes in excess of 25 percent unless erosion controls can be ensured and adequate revegetation is expected. Engineering proposals and revegetation and restoration plans would be required in these areas.

Reclamation

Current BLM policy recognizes that there may be more than one correct way to achieve successful reclamation, and a variety of methods may be appropriate to the varying circumstances. BLM should continue to allow applicants to use their own expertise in recommending and implementing construction and reclamation projects. These allowances still hold the applicant responsible for final reclamation standards of performance. All reclamation needs to conform to BLM reclamation policy (BLM, 1990a)

BLM reclamation goals emphasize (1) protection of existing native vegetation, (2) minimal disturbance of existing environment, (3) soil stabilization through establishment of ground cover, (4) establishment of native vegetation consistent with land use planning, and (5) monitoring and management of the reclamation sites to evaluate reclamation success.

All reclamation is expected to be accomplished as soon as possible after the disturbance occurs, with efforts continuing until a satisfactory revegetation cover is established and the site is stabilized (3 to 5 years). Only areas needed for construction would be allowed to be disturbed.

On all areas to be reclaimed, seed mixtures would be required to be weed-free and site-specific, composed of native species, and would be required to include species promoting soil stability. A predisturbance species composition list must be developed for each site if the project encompasses an area where there are several different plant communities present. Livestock palatability and wildlife habitat needs would be given consideration in seed mix formulation. BLM guidance for native seed use is BLM Manual 1745 (Introduction, Transplant, Augmentation, and Reestablishment of Fish, Wildlife, and Plants), and Executive Order No. 13112 (Invasive Species).

Interseeding, secondary seeding, or staggered seeding may be required to accomplish revegetation objectives. During rehabilitation of areas in important wildlife habitat, provision would be made for the establishment of native browse and forb species, if determined to be beneficial for the habitat affected. Follow-up seeding or corrective erosion control measures may be required on areas of surface disturbance which experience reclamation failure.

Trees, shrubs, and ground cover (not to be cleared from rights-of-way) would require protection from construction damage. Backfilling to preconstruction condition (in a similar sequence and density) would be required. Restoration of normal surface drainage would also be required.

Any mulch used would be free from mold, fungi, or noxious or invasive weed seeds. Mulch may include native hay, small grain straw, wood fiber, live mulch, cotton, jute, synthetic netting, and rock. Straw mulch should contain fibers long enough to facilitate crimping and provide the greatest cover.

The grantee or lessee would be responsible for the control of all noxious and invasive weed infestations on surface disturbances. Aerial application of chemicals would be prohibited within one-quarter mile of special status plant locations. Control measures would adhere to those allowed in the RFO Noxious Weed Control and Commercial Site Vegetation Control EA (WY-037-EA6-122), and Vegetation Treatment on BLM Lands in Thirteen Western States EIS and ROD (1991). Herbicide application would be monitored by the BLM authorized officer.

Types of Roads

Access Roads: Access roads should be kept to a minimum and used when dry or if all-weather surfaced. Adequate drainage and erosion minimization should be incorporated into road design. Roads should be designed to encourage the shedding of water from the surface before it gains enough concentration or velocity to cause erosion. After water is shed from the road surface energy dissipation structures should be designed, again with the goal in mind to reduce the concentration and velocity of water. There are two types of roads throughout the RFO, this discussion will be separated into two track undeveloped access roads and designed and maintained surfaced roads.

Undeveloped Two Track Roads: Use of undeveloped two tracks should be kept to a minimum and they should only be used during dry conditions, if possible. If areas are identified with multiple two tracks with the same destination, brush barriers or signing should be used to identify the best quality two-track road for use and discourage use of other unnecessary two tracks. As funding is available, these unnecessary two-tracks should be reclaimed.

If erosional features are present on necessary two tracks, including but not limited to excessive rutting with evidence of concentrated flow during storm events, sediment deposition adjacent to the two tracks, ponding in ruts, and/or ruts greater than 6 inches in depth; the road should be

considered for a designed surface road. If the road is not improved drainage should be improved by the installation of water bars, culverts, and/or wing ditches to reduce concentrated flows.

Developed or Designed Roads

Roads would be constructed as described in BLM Manual 9113. New main artery roads would be designed to reduce sediment loading to surface waters. Where necessary, running surfaces of the roads would be graveled if the base does not already contain sufficient aggregate. Developed roads would be upgraded to an all-weather surface if access will occur during winter mouths or if road is in sensitive soils.

All developed roads should be designed with and maintained to preserve some type of surface shape to reduce water concentration, surface flow, ponding and resulting safety and maintenance problems. Two commonly accepted surface shape designs are crowned roads where the center of the road is at the highest elevation and the sides are lower allowing for the shedding of water off the road surface and outsloped roads that shed water to the downslope side of the road. Insloping should only be used when outsloping or crowning is infeasible due to safety considerations or erosion on the outslope is a great concern, since drainage on the inslope will require ditches and cross-drainage. Outsloped or insloped roads should only be used on roads with less than 6 percent grade (BLM, 1982).

On surfaced road with grades greater than 8%, surface shape alone will probably not be enough to protect the road surface and cross-drainage systems should be considered (USDA, 1997). The two most common approaches are waterbars that shed water from the surface of the road and drainage ditches, or culverts to transport water from the road surface to a location where concentrated flow is dispersed. BLM manual section 9113 should be used for accepted specifications.

To control or reduce sediment from roads, guidance involving proper road placement and buffer strips to stream channels; surfacing; proper drainage; and in some cases, redesign or closure of old roads or seasonal closures, would be developed when necessary. Construction may also be prohibited during periods when soil material is saturated, frozen, or when watershed damage is likely to occur.

On newly constructed permanent roads, the placement of topsoil, seeding, and stabilization would be required on all cut and fill slopes unless conditions (e.g., rock) prohibit it. No unnecessary sidecasting of material (e.g., maintenance) on steep slopes would be allowed. Snow removal plans may be required so that snow removal does not adversely affect reclamation efforts or resources adjacent to the road.

Reclamation of abandoned roads would include requirements for reshaping, recontouring, resurfacing with topsoil, installing water bars, and seeding on the contour. The removal of structures such as bridges, culverts, cattleguards, and signs usually would be required. Stripped vegetation would be spread over the disturbance for nutrient recycling where practical. Fertilization or fencing of these disturbances would not normally be required. Additional erosion control measures (e.g., fiber matting) and road barriers to discourage travel may be required in addition to signing.

Road closures may be implemented during crucial periods (e.g., wildlife winter periods, spring runoff, and calving and fawning seasons). These would require signing or the areas being designated in a publicly available map.

Methods for shedding water from road surfaces: This can be done by installing water bars on steep sections and not allowing ruts to develop in others. Wear on access roads can be significantly reduced by minimizing use when they are wet. Good design on access roads that have a significant amount of traffic can include surfacing, installation of road drainage such as wing ditches, culverts and proper maintenance. As necessary for erosion control and energy dissipation structures such as wing ditches, riprap and culverts should be part of the road design. Riprap should be placed and outlets of culverts and the inlets of drainage structures, where possible. All riprap should be angular rock and placed on geotextile fabric Culverts should be considered for cross-drainage when travel is expected to exceed ten to fifteen vehicles per day, regardless of surface design and culverts should be 18 inches or greater in diameter (BLM Manual 9113).

Methods for designing road crossings: Active streams are those that maintain aquatic vegetation, animal or fish populations. Other stream crossings should follow BLM Manual 9113 specifications. The majority of active streams are intermittent or perennial; however there may be some portions of ephemeral systems that meet this definition. All crossings should consider the failure of the crossing during flows beyond the design capacity. This can be accomplished by allowing the road fill to be breached in pre-determined locations during storm events greater than the design capacity, and not diverting the water to a new pathway causing gullying, erosion, and formation of a new channel.

The goal of any design should be to maintain current fluvial processes for moving sediment and flow in the active channel. This results in designs that do not confine flows to only one portion of the channel or flood plain and do not result in a grade change through the crossing. Channel dimensions are a good indicator of the range of water, debris and sediment yield in the channel The active stream bed width or annual scour can be used as an estimate the area required for the crossing to pass typical (1.5 – 2 year reoccurrence) flows. Similarly, the eroded area with temporary vegetation and flood terracing can be used as indicators of extreme events for reoccurrence intervals greater than 2 years. These field measurements along with peak flow events (Miller, 2003) and other empirical methods should be used to determine design criteria for crossings.

In general, crossings designed to pass 100 year design storms would in most cases allow for unrestricted passage of flow and sediment form smaller storms. Crossing designs that simulate natural stream processes and provide unrestricted passage of flow and sediment can include bridges, low-water crossings, culverts, and bottomless culverts. The appropriate design should be chosen after careful consideration of local conditions including hydrologic conditions, soil erodibility, road utilization, and aquatic species presence.

Where new or replacement culvert designs are chosen for crossings of active streams, the Active Channel Design Option should be followed if the channel slope is less than 3%, the culvert is less than 100 feet in length, and passage is required for aquatic species. Design criteria specific to the Active Channel Design Option include the following:

- Culvert width – The minimum culvert width shall be equal to, or greater than, 1.5 times the active channel width.

- Culvert slope – The culvert shall be placed level (0% slope).

- Embedment – The bottom of the culvert shall be buried into the streambed not less than 20% of the culvert height at the outlet and not more than 40% of the culvert height at the inlet. Embedment does not apply to bottomless culverts.

At sites where the channel slope is greater 3% or culvert length would exceed 100 feet, additional consideration should be given to alternate design options such as bridges or low-water crossings due to the difficulty of providing for the passage of aquatic species through culverts installed at these sites.

Citations:

Bureau of Land Management, 1990. Wyoming Policy on Reclamation. U.S. Department of the Interior, Bureau of Land Management, Rawlins District Office, Rawlins, Wyoming. February 2, 1990.

Miller, Kirk A., 2003. Peak-Flow Characteristics of Wyoming Streams. Water-Resources Investigations Report 03-4107. USDI US Geologic Survey, Cheyenne, Wyoming, 2003.

Wyoming DEQ, 1997. Best Management Practices for Grazing: Brochure. Developed by the Wyoming Department of Environmental Quality – Non Point Source Pollution Program thorough a grant from the US Environmental Protection Agency.

(USDA, 1997) Traveled Way Surface Shape. USDA Forest Service, Technology & Development Program, October 1997.

APPENDIX L

RESOURCE CONCERNS AND ASSOCIATED PROTECTION MEASURES PROPOSED UNDER ALTERNATIVE C

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
Water and Soil Management		
Steep Slopes >25%, From 30 meter DEM data. These less steep slopes present more complexity in planning, road design, and can require larger pads. **Appendix M Maps: Alternative C--Slopes >25%**	1) No pad, compressor or water transfer sites can be located in these areas.	Wyoming Standard Mitigation Guidelines
Perennial Waters, Wetlands, Identified on National Wetlands Inventory or PFC with 500ft. Buffer on waters and PFC. **Appendix M Maps: Alternative C—Perennial Surface Waters and Wetlands**	1) No pad, compressor or water transfer sites can be located in these areas.	E.O. 11990 and 11988
Topsoils with excess salts providing difficulty with reclamation. Reclamation success is essential for modification of impacts to surface hydrology, especially the interim reclamation. Increasing reclamation success has many benefits to other resources. **Appendix M Maps: Topsoils with Excess Salts**	1) Pump reserve pit and do earth work for reclamation right after drilling, put in top soil and plant first good season, interim reclamation will be completed one year after spud date. 2) Low impact road design for resource roads (roads into individual pads) on slopes < 5%, if road can be built with no side slopes. This will include ditch-witching utilities within the ROW, brush beating, some type of fabric or matting and gravel. 3) Improve road surface on newly constructed or improved local and collector roads with 95% compaction on the road base and non-chlorine dust abatement product or suitable alternative treatment each year. 4) Put together seed mix that includes salt tolerant plants.	Cumulative Impacts; Salinity concerns in the Colorado River Basin.
Soils with high runoff potential contribute to higher peak flows and can cause hillslope erosion by forming rills and gullies. **Appendix M Maps: Alternative C--Soils with High Runoff Potential**	1) Reduce pad density to 4 locations per section and the associated infrastructure and limit initial disturbance (i.e. short-term) total to < 20 acres per section. 2) Place waddles in any potential flow path and at culvert entrances and exits. 3) Deep ripping (18 inches or more) before planting to increase percolation. 4) Closed system, pitless, or shared pit drilling. 5) Low impact road design for resource roads (roads into individual pads) on slopes < 5%. This will include ditch-witching utilities within the ROW, brush beating, some type of fabric or matting and gravel. 6) Crimped weed-free hay stubble mulch to increase surface roughness.	Cumulative Impacts; the Colorado River basin has been a focus for sediment delivery and soil loss since the 1930s.

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
Soils with severe road rating typically dominated by one soil particle size component and road bases can become very unstable with insufficient maintenance. **Appendix M Maps: Soils with Severe Road Rating**	1) Low impact road design for resource roads (roads into individual pads) on slopes < 5%. This will include ditch-witching utilities within the ROW, brush beating, some type of fabric or matting and gravel. 2) Improve road surface on newly constructed or improved local and collector roads with 95% compaction on the road base and non-chlorine dust abatement product or suitable alternative treatment each year.	Cumulative Impacts; the Colorado River basin has been a focus for sediment delivery and soil loss since the 1930s.
Soils with poor topsoil ratings make reclamation difficult and can leave soils susceptible to erosion. Reclamation success is essential for modification of impacts to surface hydrology, especially the interim reclamation. Increasing reclamation success has many benefits to other resources. **Appendix M Maps: Soils with Poor/Fair Topsoil Ratings**	1) Pump reserve pit and do earth work for reclamation right after drilling, put in top soil and plant 1st good season, interim reclamation will be completed 1 year after spud date. 2) Crimped weed-free hay stubble mulch to increase surface roughness. 3) Use silt fencing to reduce wind erosion during construction. 5) Apply soil amendments to increase reclamation success unless testing demonstrates no need for amendments.	Cumulative Impacts; the Colorado River basin has been a focus for sediment delivery and soil loss since the 1930s.
Vegetation Resources		
Vegetation communities on >8% slopes present reclamation difficulties. **Appendix M Maps**	Reduced initial surface disturbance (i.e. short-term) total to < 20 acres per section	
The limited geographic extent of certain vegetation communities and their importance to a variety of wildlife species warrant special consideration. **Appendix M Maps: Project Area with Vegetation Communities**	1) Avoid surface disturbances within aspen, juniper-woodland, mahogany, and serviceberry communities. 2) Limit surface disturbances within the silver sagebrush/bitterbrush vegetation community to < 20 acres/mi2.	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002)
Rangeland Resources		
Loss of livestock; disruption of management operations.	1) Operators shall establish and enforce speed limits throughout the project area 2) Erect signs in lambing/calving areas, shipping pastures, or adjacent to working corrals to warn vehicle operators	

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
Disruption of management operations. **Appendix M Maps: Project Area with Grazing Allotments**	1) Operators shall provide a plan specific to pastures or regions so livestock operators can plan activities/work around development to reduce conflicts	
Dust on vegetation and erosion	1) Improve road surface on newly constructed or improved local and collector roads with 95% compaction on the road base and non-chlorine dust abatement product or suitable alternative treatment each year	
Wildlife Resource Management		
Disturbance of greater sage-grouse and Columbian sharp-tailed grouse nesting & brood rearing habitat. **Appendix M Maps: Alternative C – Greater Sage Grouse**	1) Limit initial disturbance (i.e. short-term) total to < 20 acres per section	Minimum programmatic standards recommended by the Wyoming Game and Fish Department to sustain wildlife habitats affected by oil and gas development (WGFD 2004)
Disturbance of winter relief habitats for greater sage-grouse and Columbian sharp-tailed grouse. **Appendix M Maps: Alternative C – Grouse Severe Winter Relief Habitat**	1) No surface disturbance	Vegetation and Habitat Analysis of Critical Wintering Areas for Greater Sage-Grouse (HWA 2004b)
Disturbance of big game crucial winter range. **Appendix M Maps: Seasonal pronghorn antelope, mule deer and elk ranges (3 Maps)**	1) Limit initial disturbance (i.e. short-term) total to < 20 acres per section	Minimum programmatic standards recommended by the Wyoming Game and Fish Department to sustain wildlife habitats affected by oil and gas development (WGFD 2004)
Visual Resource Management		

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
Failure to use special mitigations will result in a project that will exceed VRM Class III Management Objectives and therefore be out of compliance with Land Use Planning guidance. Minimizing surface disturbance and aboveground facilities will help minimize visual impacts. Maximizing facility distance from primary roads will help minimize visual impacts. Using any topographic screening available to hide facilities and roads will help minimize visual impacts. **Appendix M Maps: Alternative C--Areas Visible from Main Roads in VRM Class III with Slopes <5%**	In visible portions of VRM Class III areas (Map 4.9), the following apply: 1) Pads shall not be located on or near ridgelines - use subsurface or low-profile facilities to prevent protrusion above horizon line when viewed from any State, County or BLM road. 2) Maximize pad distance from State, County or BLM roads. 3) Low impact road design for resource roads (roads into individual pads) on slopes < 5%, if road can be built with no side slopes. This will include ditch-witching utilities within the ROW, brush beating, some type of fabric or matting and gravel. (See Map 2.6) 4) Minimize pad size - use pitless, shared pit or closed system drilling. 5) Pump reserve pit and do earth work for reclamation right after drilling, put in top soil and plant first good season, interim reclamation will be completed one year after spud date.	VRM BMPs for Fluid Minerals, VRM H-8400-1, Land Use Planning H-1601-1
Cow Butte/Wild Cow SMA		
Existing road network **Appendix M Maps: Alternative C—Special Management Areas Overview**	1) Road density within the SMA targeted for less than 3 miles/mile^2. 2) Where existing road paths do not provide sufficient lease access or are located within highly erosive soils or in proximity to sensitive wildlife resources, reclamation of existing roads (either inside or outside the ARPA) would provide for the construction of new road paths 3) Improvement of existing roads or construction of new roads would be designed to minimize hydrologic alteration. Specific road design criteria would be based on site-specific review and likely include a combination of mitigation options	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002). These roads are currently known to cause accelerated erosion and hydrologic alteration. Upgrading these roads to improved or low-impact design specifications would decrease these impacts while allowing vehicular access to lease holdings. Additionally, utilization of appropriate road designs would increase the effectiveness of the existing transportation network.

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
Human presence	1) Existing levels of public access would be maintained. In most cases, this would require new and improved roads be gated. 2) Remote monitoring of well locations would be required where feasible.	Minimum programmatic standards recommended by the Wyoming Game and Fish Department to sustain wildlife habitats affected by oil and gas development (WGFD 2004). There is currently no public access to the majority of the SMA. Maintaining a limited human presence within this area would help to maintain a movement corridor for big game and limit disturbance of leks and raptor nests.
Wildlife movements	1) Convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement throughout the SMA, and in coordination with grazing permittees.	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002). Improving big game movement through or across fences would help to mitigate the additional stresses of development within the ARPA.
Limited vegetation communities. **Appendix M Maps: Project Area with Vegetation Communities**	1) No surface disturbances within aspen, mahogany, and serviceberry communities.	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002)
Historic Trails SMA		
Historic trail corridors **Appendix M Maps: Alternative C--Historic Trails and 2-Mile Visibility**	1) Brush hog and gravel surface for temporary roads at the drilling phase instead of constructing crowned and ditched roads on all locations. 2) Begin reclamation at the time most optimal to regenerate the native species. Replace native shrubs to decrease visibility. 3) Use existing roads/two-tracks if doing so would minimize visibility otherwise construct roads in minimally visible areas. 4) Limit trail crossings to existing corridors. 5) Construct smaller well pads. 6) Construct low-impact roads. 7) Require multiple well locations per pad in order to decrease visibility.	Wyoming State Protocol - Approved procedures for the implementation of Section 106 NHPA and 36 CFR 800
Historic trails within the ARPA	1) Allow no surface disturbance within ¼ mile of contributing segments of historic trails, including the Overland and Rawlins to Baggs Freight Road or the trail's associated sites. 2) Limit trail crossings to existing disturbance corridors.	Wyoming State Protocol - Approved procedures for the implementation of Section 106 NHPA and 36 CFR 800

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
Upper Muddy Creek Watershed/Grizzly SMA		
Additional road development would alter hydrologic conditions that create and maintain key habitat features of importance to BLM sensitive fishes (Bower 2005). Given the limited distribution of these fishes, alteration of the suitability of habitats within the SMA would likely increase the validity of listing petitions under the Endangered Species Act. **Appendix M Maps: Alternative C—Special Management Areas Overview**	1) Road density within the SMA targeted for less than 3 miles/mile^2. 2) Transportation and well access roads would utilize existing road paths where feasible. 3) Where existing road paths do not provide sufficient lease access or are located within highly erosive soils or in proximity to sensitive wildlife resources, reclamation of existing roads within the SMA (either inside or outside the ARPA) would provide for the construction of new road paths 4) Improvement of existing roads or construction of new roads would be designed to minimize hydrologic alteration. Specific road design criteria would be based on site-specific review and likely include a combination of mitigation options 5) Detailed development, transportation, and reclamation plans, including road design, specific to those areas within the SMA will be required.	BLM Wyoming Sensitive Species List (USDI-BLM 2002a), BLM 6840 policy for special status species, Range-wide Conservation Agreement for Roundtail Chub, *Gila robusta*, Bluehead Sucker, *Catostomus discobolus*, and Flannelmouth Sucker, *Catostomus latipinnis* (UDNR 2004). These roads are currently known to cause accelerated erosion and hydrologic alteration. Upgrading these roads to improved or low-impact design specifications would decrease these impacts while allowing vehicular access to lease holdings. Additionally, utilization of appropriate road designs would increase the effectiveness of the existing transportation network.
Slopes > 8% within the Upper Muddy Creek Watershed/Grizzly SMA boundary from 30-m DEM. Road construction on steep slopes would exacerbate the alteration of hydrologic conditions that create and maintain key habitat features of importance to BLM sensitive fishes. **Appendix M Maps: Alternative C—Muddy Creek SMA Slopes >8%**	1) No surface disturbance 2) Detailed transportation plan required in order to avoid areas of > 8% slope	BLM Wyoming Sensitive Species List (USDI-BLM 2002a), BLM 6840 policy for special status species, Range-wide Conservation Agreement for Roundtail Chub, *Gila robusta*, Bluehead Sucker, *Catostomus discobolus*, and Flannelmouth Sucker, *Catostomus latipinnis* (UDNR 2004). Improved road designs frequently result in alteration of hydrologic conditions. Given the limited feasibility of utilizing low-impact road designs on slopes greater than 8%, these areas will be avoided.

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
1:24,000 NHD within the Upper Muddy Creek Watershed/Grizzly SMA boundary. The fragmentation of fish habitats and wildlife corridors as well as risks posed by the increased probability of exotic species introductions warrant avoidance of additional road crossings of Muddy Creek.	1) No new road crossings of Muddy Creek 2) Detailed development and transportation plan required in order to design access routes that avoid Muddy Creek	BLM Wyoming Sensitive Species List (USDI-BLM 2002a), BLM 6840 policy for special status species, Range-wide Conservation Agreement for Roundtail Chub, *Gila robusta*, Bluehead Sucker, *Catostomus discobolus*, and Flannelmouth Sucker, *Catostomus latipinnis* (UDNR 2004). Sufficient access to lease holdings can be provided through the transportation planning process.
Maintaining a limited human presence within this area would help to maintain a movement corridor for big game and limit disturbance of sage-grouse leks and raptor nests.	1) Existing levels of public access would be maintained. In most cases, this would require new and improved roads be gated. 2) Remote monitoring of well locations would be required where feasible.	BMP's, Minimum programmatic standards recommended by the Wyoming Game and Fish Department to sustain wildlife habitats affected by oil and gas development (WGFD 2004). There is currently no public access to the majority of the SMA.
Chloride deicing agents are toxic to a variety of plants, fish, and other aquatic organisms and tend to increase the mobility of chemical elements in soil, such as heavy metals (Amrhein 1992; National Research Council 1991).	1) Use only non-chlorine deicing and dust control agents within the Upper Muddy Creek Watershed/Grizzly SMA.	BLM Wyoming Sensitive Species List (USDI-BLM 2002a), BLM 6840 policy for special status species, Range-wide Conservation Agreement for Roundtail Chub, *Gila robusta*, Bluehead Sucker, *Catostomus discobolus*, and Flannelmouth Sucker, *Catostomus latipinnis* (UDNR 2004). Alternative, non-chloride deicing and dust control products are readily available.
The limited geographic extent of certain vegetation communities and their importance to a variety of wildlife species warrant special consideration.	1) No surface disturbances within aspen, juniper-woodland, true mountain mahogany, and serviceberry communities.	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002)
The combination of increased disturbance of big game resulting from development activities and existing fragmentation of movement corridors by fences would likely result in increased mortality	1) Convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement throughout the SMA, and in coordination with grazing permittees.	BMP's, Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002). Improvement of big game movement through fences would help to mitigate the additional stresses of development within the ARPA.

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
Sand Hills SMA		
There is currently an extensive road network within the SMA including those portions within the ARPA. Reducing the density of roads within the area and incorporating appropriate designs when improving existing roads would help to reduce disturbance of the unique vegetation community important to big game, greater sage-grouse, and Columbian sharp-tailed grouse.	1) Net reduction in road density within the SMA to a target of less than 3 miles/mile^2 2) Transportation and well access roads would utilize existing road paths where feasible 3) Where existing road paths do not provide sufficient lease access or are located within sensitive vegetation, highly erosive soils, or in proximity to sensitive wildlife resources, reclamation of existing roads (either inside or outside the ARPA) would provide for the construction of new road paths 4) Improvement of existing roads or construction of new roads would be designed to minimize alteration of sensitive vegetation communities. 5) Detailed development, transportation, and reclamation plans, including road design, specific to those areas within the SMA will be required.	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002). These roads are currently known to cause accelerated erosion of active dune complexes and associated disturbance of rare plant communities. Creation of new road paths would increase the potential for loss of rare vegetation communities through wind erosion of active dune complexes. The use of existing roads and appropriate designs for road improvement would allow for rapid revegetation and limit the disturbance of rare plant communities. Additionally, utilization of appropriate road designs would increase the effectiveness of the existing transportation network.
Maintaining a limited human presence within this area would help to maintain a movement corridor for big game and limit disturbance of leks and raptor nests.	1) Existing levels of public access would be maintained. In most cases, this would require new and improved roads be seasonally closed. 2) Remote monitoring of well locations would be required where feasible.	Minimum programmatic standards recommended by the Wyoming Game and Fish Department to sustain wildlife habitats affected by oil and gas development (WGFD 2004). There is currently no public access to the majority of the SMA.
Chloride deicing agents are toxic to a variety of plants and tend to increase the mobility of chemical elements in soil, such as heavy metals (Amrhein 1992; National Research Council 1991).	1) Use only non-chlorine deicing and dust control agents within the Sand Hills SMA	To protect the silver sagebrush/bitterbrush community. Alternative, non-chloride deicing and dust control products are readily available.
The limited geographic extent of certain vegetation communities and their importance to a variety of wildlife species warrant special consideration.	1) Limit surface disturbances within the silver sagebrush/bitterbrush community of the Sand Hills to < 20 acres/mi^2.	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002). The Sand Hills plant community is unique within the State of Wyoming. It also provides important seasonal and crucial winter habitats to a variety of wildlife species.

Data Source Resource Concern	Protection Measure	Justification Assumptions for Analysis/Comments
The combination of increased disturbance of big game resulting from development activities and existing fragmentation of movement corridors by fences would likely result in increased mortality.	1) Convert fences to BLM standards or designs (e.g., rail top fence) to facilitate big game movement throughout the SMA, and in coordination with grazing permittees.	Standards and Guidelines assessment for Upper Colorado River Basin (BLM 2002). Improvement of big game movement through fence crossings would help to mitigate the additional stresses of development within the ARPA.
Historic Trails SMA	See Historic Trails SMA for special protective measures.	Wyoming State Protocol - Approved procedures for the implementation of Section 106 NHPA and 36 CFR 800
JO Ranch property **Appendix M Maps: Alternative C—Special Management Areas Overview**	1) No surface disturbance within the 18 acres surrounding JO Ranch Headquarters.	Wyoming State Protocol - Approved procedures for the implementation of Section 106 NHPA and 36 CFR 800

APPENDIX K

PLAN OF DEVELOPMENT / DETAILED PROPOSED ACTION

APPENDIX K – PLAN OF DEVELOPMENT/DETAILED PROPOSED ACTION

K.1PLAN OF DEVELOPMENT/Detailed Proposed Action

K.1.1 Preconstruction Planning and Site Layout

Development activities proposed on fee and State of Wyoming surface lands would be approved by the Wyoming Oil & Gas Conservation Commission (WOGCC). The WOGCC permitting procedures require filing an APD with the WOGCC and obtaining an ROW from the surface owner.

The Operators would follow the procedures outlined below to gain approval for proposed activities on BLM-administered lands or minerals within the ARPA. The procedures described below are applicable to CBNG drilling and production activities (1,800-well program) and the deeper conventional natural gas drilling and production activities (200-well program) unless otherwise noted.

- Annual work plans for each developing or operational POD will be used instead of piecemeal individual APD filings. Each year on April 1, the Operators will submit to the BLM Rawlins Field Office comprehensive annual work plans for the following year, including APD packages and other appropriate permit application materials for the construction and development activities. The BLM, in conjunction with the Operators, will perform the usual on-site reviews and perform the other tasks necessary to prepare the program of work for site specific analysis under NEPA and permitting approval prior to the next drilling season. This procedure will allow for economies of scale with the NEPA process and provide a more comprehensive appraisal of the proposed action and their effects on the environment. This program should also reduce processing time for APDs. The Operators and the BLM will also assess and decide the method of analysis, including how the NEPA related work will be performed (either in-house or through third party contractors). Otherwise unplanned construction needs that arise during the course of the year and outside of the annual plan may be brought forward and proposed by operators and will be dealt with by the BLM appropriately, however the intent is to normally avoid individual APD submission and consideration.

  Annual work or site specific plans for developing or operational PODs will include geo-referenced information compatible with ArcMap that details pad and well locations; pipeline routes; water transfer stations; road locations (resource, collector or local); road construction techniques (including gravel type and source); wing ditch, water bar and culvert placement, any closed system livestock watering facilities, any potential fence modification or cattle guard installations, injection well locations; and any existing infrastructure (wells, roads, pipelines etc.) in the townships receiving new development.

- The proposed facilities would be staked by the Operators and inspected by an interdisciplinary team and/or an official from the BLM to ensure consistency with the approved RMP and oil and gas lease stipulations.

- More detailed descriptions of the proposed activity or construction plans would be submitted to the BLM by the Operators when required for the proposed development. The plans would address concerns that may exist concerning construction standards, required mitigation, etc. Negotiation of these plans between the Operators and the BLM, if necessary to resolve differences, would be based on field inspection findings and would take place either during

or after the BLM onsite inspection. Submissions of maps will include the associated GIS geo-referenced information.

- The Operators and/or their contractors would revise APD/ROWs, as necessary, per negotiations with the BLM. The BLM would complete a project-specific environmental analysis that incorporates agreed upon construction and mitigation standards as detailed above. The BLM would then approve the annual proposal and attach the Conditions of Approval to the permit. The Operators must then commence the proposed activity within one year.

Following is a general discussion of proposed construction techniques to be used by the Operators. These construction techniques would be applicable to drill sites, pipelines, and access roads within the ARPA, and may vary between the well sites.

K.1.2 Construction and Drilling Phase

K.1.2.1 Access Road Construction

The road network within the ARPA is discussed in more detail in Chapter 3, Affected Environment. A typical roadway cross-section with width specifications is shown on Figure K-1.

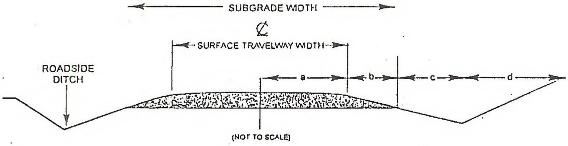
BLM Manual Section 9113 road classifications categorize ARPA roads into three separate classes:

1) Collector Roads. These roads normally provide primary access to large blocks of land and connect with or are extensions of a public road system such as WYO 789. Collector roads are two-lane and require application of the highest road standards. The predominant design speed is 30 to 50 mph depending on terrain and/or as determined by BLM, and the subgrade width is a minimum of 28 feet (24 feet full-surfaced travelway). A typical roadway cross-section with width specifications is shown in Figure K-1.

2) Local Roads. These are low volume roads providing the internal access network within an oil/gas field such as Carbon County Road 608. The design speed is 20-50 mph depending on terrain, and the sub grade width is normally 24 feet (20 feet full-surfaced travelway). Low volume roads in mountainous terrain may be single-lane roads with turnouts.

3) Resource Roads. These are normally spur roads that provide point access. Roads servicing individual oil/gas exploration and production locations fall within this classification. The road has a design speed of 15-30 mph and is constructed to a minimum subgrade of 16 feet (12 feet minimum full-surfaced travelway) with intervisible turnouts.

The Operators propose to construct required new access roads across public lands in accordance with BLM Manual 9113 standards. Roads would be located to minimize disturbances and maximize transportation efficiency. Roads would be closed and reclaimed by the Operators when they are no longer required for production operations, unless otherwise directed by the BLM.



	Minimum Subgrade Width (ft.)	Minimum Surfaced Travelway Width (ft)	a (ft)	b (ft)	c (ft)	d (ft)	Approximate Disturbance Width (ft)	Total ROW Width (ft)	Design Speed (mph)
Resource Road	16	12	6	2	4	8	40	50	15-30
Local Road	24	20	10	2	4	8	48	55	20-50
Collector Road	28	24	12	2	4	8	52	60	30-50

DIAGRAM OF TYPICAL TURNOUTS ON RESOURCE ROADS (PLAN VIEW)

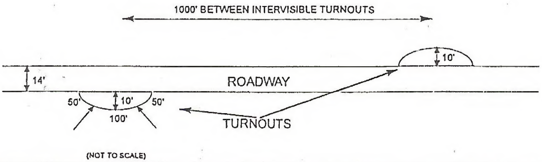


Figure K-1. Typical Roadway Cross-Section with Width Specifications

Based on onsite reviews, roads would be located to minimize disturbances and maximize transportation efficiency. The operators propose to construct access roads across public lands to wells in accordance with BLM Manual 9113 standards. New access roads would be designed and constructed to resource road standards to facilitate reclamation should the well be a dry hole. Roads located on private lands would be constructed in accordance with standards imposed by the private land owner. The number of roads would be limited to decrease potential impacts by discouraging development of looped roads and by accessing wells from short resource roads off the local roads. Roads would be closed and reclaimed by the operators when they are no longer required for production operations, unless otherwise directed by the BLM or private landowners. Roads would be designed to minimize disturbance and would be built and maintained as specified by the BLM to provide safe operating conditions at all times. Surface disturbance would be contained within the road ROW.

Construction equipment and techniques used by the operators would be to the standards found in the BLM Handbook (e.g., crown-and-ditch method). Should soft spots develop on the roadway during construction or drilling operations, they would be immediately covered with crushed rock or gravel. Where identified during on-site review by the BLM, problem areas on access roads to producing well sites would be graveled to a depth of 4 to 6 inches to reduce erosion and sedimentation. Graveling would be accomplished within a time period specified by BLM. Surfacing and base course materials would be obtained from existing, operational gravel pits located on fee or federal sources near the project area. Respreading of topsoil and windrowed vegetation to the side slopes of the newly constructed access roads and revegetation would begin the first appropriate season following the well going into production. Reclamation measures would be implemented the first operating season after well abandonment. The access road to an unproductive well site would be reclaimed upon abandonment of the well using stockpiled topsoil and a seed mixture contained in the approved APD/ROW.

In the event drilling is non-productive, all disturbed areas, including the well site and new access road, would be reclaimed to the approximate landform that existed prior to construction. Reclamation and site stabilization techniques would be applied as specified in the APD Surface Use Plan or the ROW Plan of Development (POD). If drilling is productive, all access roads to the well site would remain in place for well servicing activities (i.e., maintenance, improvements, etc.). Partial reclamation would be completed on segments of the well pad and access road ROW no longer needed.

Small drainage crossings on access routes within the project area would be either low water crossings or crossings using culverts. Low water crossings would be used in shallow channel crossings. Crossings of larger channels within the project area would consist of excavating an area approximately four feet deep under the travelway and filling it with rock and gravel to the level of the drainage bottom. Channel banks on either side of such crossings would be cut down to reduce grade where necessary. Culverts would be installed on smaller, steeper channel crossings. Topsoil would be saved before channel-crossing construction occurs. Also, the total area to be disturbed would be flagged on the ground before construction begins.

The Operators estimate that each proposed new well would require an average of 2,640 feet (1/2 mile) of new or upgraded road construction. They further estimate that approximately 0.5 miles of pipeline co-located in or adjacent to road beds will be required plus an additional 15 miles of larger sales pipeline running from the Muddy Mountain vicinity to the Brown Cow POD.

K.1.2.2 Well Pad Design and Construction

A graded well pad would be constructed at each well site using cut and fill construction techniques. Figure K-2 is a schematic drawing of a typical drill site layout. The dimensions of each well pad would be approximately 360 feet by 240 feet. Each well site would initially disturb an estimated 2 acres and be reclaimed to 1 acre after the cessation of drilling.

Generally, two temporary mud pits 50 feet wide by 10 feet deep by 50 feet long, constructed adjacent to each other and connected by a small overflow trench, would be excavated at each well and reclaimed after completion operations. Topsoil would be removed and stockpiled prior to excavating the pit as, required by BLM. The Operators estimate the reserve pits would be open from two to eight weeks to allow for evaporation of pit fluids which consists primarily of water. During this time, the pits would be fenced on all sides to prohibit wildlife and livestock from falling into the pit.

In the event drilling is non-productive at any given site, all disturbed areas associated with that site, including the well site and new access road, would be reclaimed to the approximate landform existing prior to construction. Reclamation and site stabilization techniques would be applied as specified in the Master Surface Use Plan (MSUP). If drilling is productive, all access roads to the well site would remain in place for well-servicing activities (i.e., maintenance, improvements, etc.). Interim reclamation would be completed on segments of the well pad and access road ROW that are no longer needed.

K.1.2.3 Drilling and Completion Operations

K.1.2.3.1 Coalbed Natural Gas

The natural gas and water injection wells would be drilled with conventional drilling rigs. Additional equipment and materials needed for drilling operations would be trucked to the well site. Water for use in drilling the wells would be obtained from existing wells completed in the coal seams of the Mesaverde. Approximately 700 barrels (29,400 gallons) of water would be needed for drilling each CBNG well. The actual water volume used in drilling operations would depend on the depth of the well and any losses that might occur during drilling. The proposed action would require an additional approximately 96,000 gallons (or 0.295 acre-feet) of water per well for cement preparation, well stimulation, and dust control. Based on existing hydrogeologic information, groundwater in the coal seams at the completion depths in the existing natural gas wells is hydraulically isolated from shallow groundwater and surface water resources.

Drilling mud would consist of native mud and bentonite. As down hole conditions dictate, small amounts of polymer additives and/or potassium chloride salts may be added for hole cleaning and clay stabilization. Drilling depths for the Mesaverde coals generally range from 250 feet to 6,000 feet and the producing formation would be exposed to the drill bore through perforations. The well control system would be designed to meet the conditions likely to be encountered in the hole and would be in conformance with BLM and State of Wyoming requirements. A completed CBNG well bore is shown in Figure K-3.

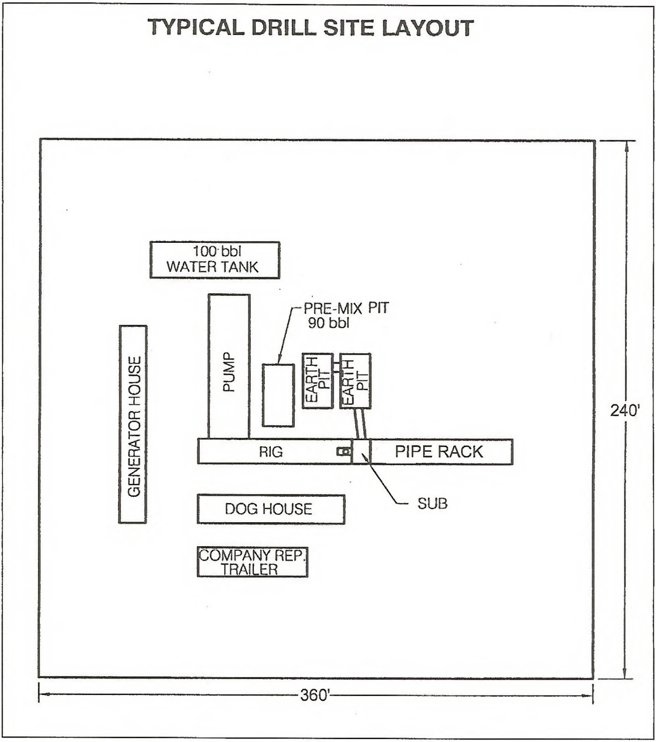


Figure K-2. Typical Drill Site Layout – Atlantic Rim Natural Gas Project

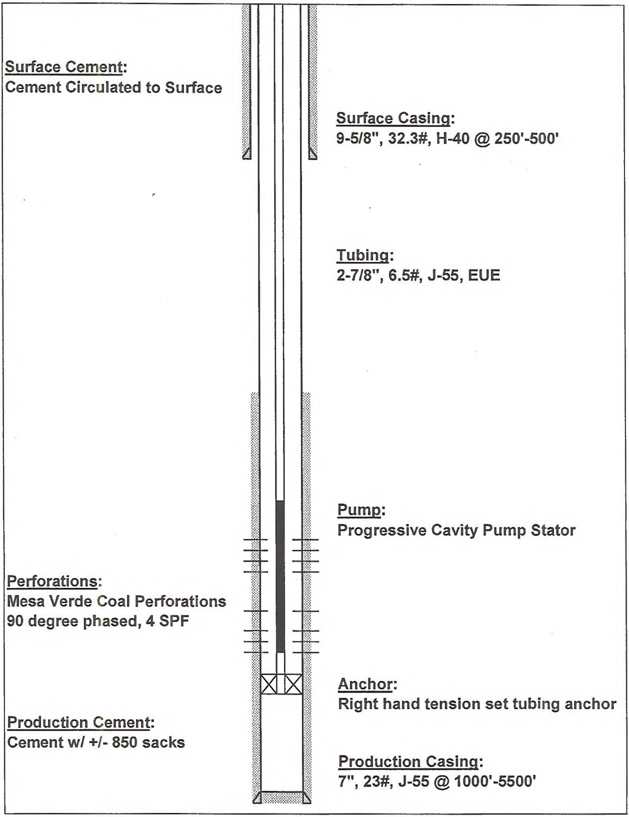


Figure K-3. Completed CBNG Well Bore – Atlantic Rim Natural Gas Project.

The drilling and completion operation for a well normally requires approximately ten to fifteen people at a time, including personnel for logging and cementing activities. Each well would be drilled within a period of seven to ten days. A well completion program may be initiated to stimulate production of gas and to determine gas and water production characteristics in preparation for production of gas from a drilled, cased, and cemented well. A mobile completion rig similar to the drill rig may be transported to the well site and used to complete each well. Completion operations are expected to average two to five days per well. Upon receiving applicable permits, CBNG may be flared or vented and water temporarily discharged and contained in the reserve pit or trucked to an alternate disposal site during the testing period. If determined to be productive, wells would be shut-in until pipelines and other production facilities are operational.

K.1.2.3.2 Deeper, Conventional Formations

Each gas drilling operation, for deeper conventional formations, would require transport of approximately 35 truckloads of drilling-related equipment and materials to facilitate the drilling operation. This number includes transportation of the drill rig, drill pipe, drilling fluid products, and related support equipment, but does not include the truck traffic required for re-supplying the operation (e.g., fuel, drilling fluid additives, etc.). Additional traffic would be variable, depending on the phases of the drilling operation, but should average eight or nine vehicles per day per drill site throughout the drilling operation, with substantially higher peaks during rig set-up and relocation and during certain completion activities. Total rig-up activities and installation of ancillary facilities would take approximately three days to complete.

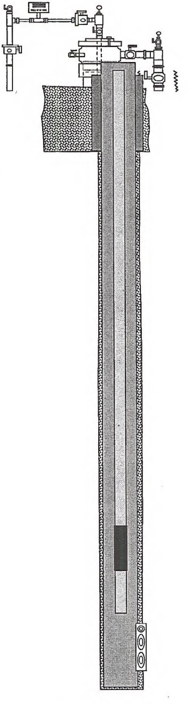
Drilling operations would be spread over the 20-year life of field development, with approximately 15 to 20 wells drilled each year. The number of wells drilled annually would depend on such factors as market prices, permit approval, and rig availability. Completion operations for each productive well would commence as soon as possible after the drilling rig moves off location.

The geologic formations to be tested for conventional natural gas production in the project area are the Mesaverde and Almond Formations. The drilling depth may vary from 500 down to 10,000 feet for a conventional well drilled requiring approximately 20 to 30 days to drill vertically, barring any major drilling problems. Figure K-4 shows a completed well bore for a conventional gas well.

Water, for drilling and service trailer use, would be obtained from State of Wyoming approved locations or local water source wells. Water requirements for drilling conventional wells average approximately 11,000 barrels (bbls) per well (462,000 gallons). The Operators intend to use freshwater-based mud for the majority of their drilling operations.

Well completion operations involve the placement and cementing of well casing and perforation, stimulation and testing of potentially productive zones. Well casing involves running steel casing pipe into the open borehole and cementing the pipe in place. Perforation, stimulation, and testing require large equipment to be transported and used at the well site, and flaring of produced gas. A typical cased well bore would consist of conductor pipe, surface casing, and production casing. Well completion operations involve the placement and cementing of well casing.

Well Name *Typical Conventional Well*
Field *Atlantic Rim*



Surface Casing

Size & Wt	*9-5/8" 36#*
Depth	*370'*
Cement:	*Volume sufficient to circulate cement to surface*
Drill Bit Size	*8-3/4"*
Drill Depth	*5,800'*

Production Casing

Size & Wt	*7" 23# or 5 1/2" 17# depending upon completion needs*
Depth	*5,800'*
Cement:	*Volume sufficient to isolate objective intervals*

Tubing

Size & Wt	*2-7/8" 6.5#*
Depth	*5,650'*
Packer	*Type and need determined by production conditions*

Pump

Type	*Type and need determined by production conditions*
Depth	*5,650'*

Perforated Interval

Length of interval and number of holes dependent upon thickness and number of prospective zones encountered

Figure K-4. Completed Conventional Well Bore - Atlantic Rim Natural Gas Project.

Surface casing would be set at the start of drilling operations to prevent gas, oil, condensate, or water from migrating from formation to formation, to isolate producing zones, to isolate and protect surface formations and to attach pressure control equipment. Setting and cementing of production casing provides separation and isolation from abnormally pressured zones, usable water zones, and other mineral deposits. The well casing would be perforated in the productive interval to allow the flow of hydrocarbons to the surface. Approximately 10,000 barrels of water may be required in the completing and testing operations per conventional natural gas well. Most completions use a string of tubing that is inserted in the casing to the top of the perforated productive zone to allow gas, condensate, and water to flow to the surface where it is collected, measured, and contained. Completion operations typically last up to 60 days for deep tests.

K.1.2.3.3 Injection Wells

Drilling of the injection wells would be accomplished with the same equipment and personnel used to drill the CBNG wells. Depth of the injection wells is expected to range from 3,200 to 6,400 feet in the Hatfield, Cherokee, and/or Deep Creek sands formations. Drilling and completion of each injection well is expected to take approximately seven to 14 days and installation of surface equipment, holding tanks and pumping equipment, an additional 14 days. A schematic of a typical injection well is shown in Figure K-5.

K.1.3 Production Operations

K.1.3.1 Well Production Facilities

Wellhead facilities would be installed if the wells are productive. A weatherproof covering would be placed over some wellhead facilities and a small shed may need to be constructed over others. The type and amount of gas dictates the design variances. A down hole pump would be used to produce water from the cased and perforated pay intervals. The long-term surface disturbance at each productive well location where cut and fill construction techniques are used would encompass approximately 1 acre. Well site production facilities typically would be fenced or otherwise removed from existing uses. A typical production well site is shown in Figure K-6.

Pipeline trenches for well gathering lines are expected to disturb 15-foot wide corridors within the 30-foot wide temporary construction ROW, which would be reclaimed as soon as practical after construction is completed. The remaining 15 feet of the 30-foot ROW would be used to transport machinery, personnel, and equipment for the installation of flowlines and electrical lines, as well as to give working room for the machinery, personnel, and equipment during the installation process. Trenches would be constructed along the access roads wherever possible. Separate gathering lines would be buried in the trenches and would transport CBNG to the metering facility and compressor station and produced water to the injection wells.

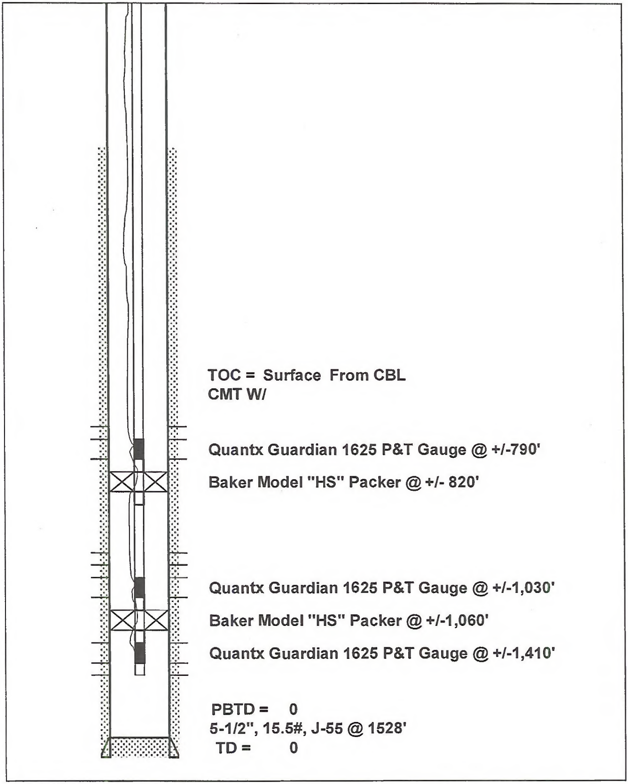


Figure K-5. Typical Injection Well Bore – Atlantic Rim Natural Gas Project.

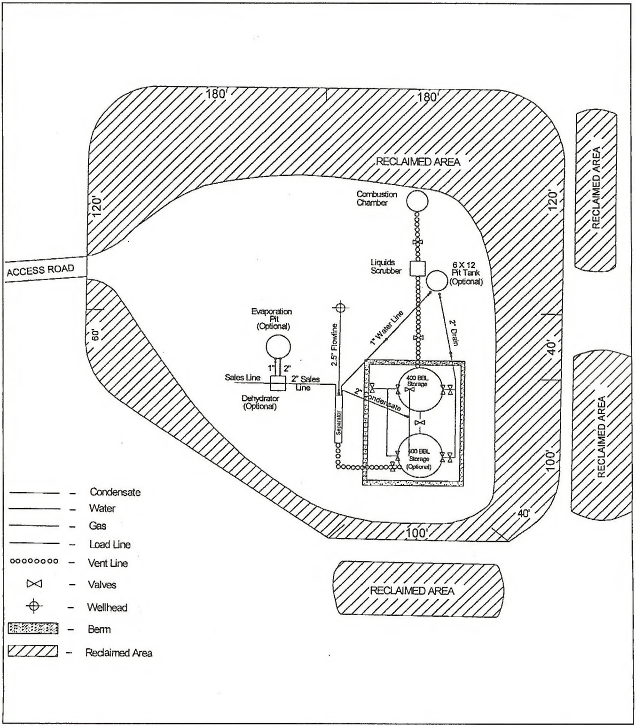


Figure K-6. Typical Production Well Site – Atlantic Rim Natural Gas Project.

At the conclusion of the Project, roads, culverts, cattle guards, pipelines, stock watering facilities, or other structures could be left in place for any beneficial use, as designated by the BLM. Water wells and produced water would be available to the BLM, if appropriations, diversion, and storage rights are obtained from the appropriate state agencies. All federally-owned lands containing disturbed areas or facilities that are no longer needed would be reclaimed.

K.1.3.2 Electric Power Generation and Power Lines

Electricity produced via generators at compressor sites would be used to power pumps during well development and to initiate and maintain production. Either natural gas engines or propane-fired engines would be used to run generators where the utility power capacity in the area is not sufficient. These gas/propane fired engines would be used on a temporary basis at individual wells until additional electric distribution lines can be installed with adequate electrical capacity. If booster or blower units are required on the wells, electrical motors or natural gas-fired reciprocating or micro turbine engines would power these units. Future compressors are anticipated to be powered by natural gas engines or electric motors. All distribution power lines (12.5 kV or lower) in the ARPA would be buried.

Introduction of electrical service may be proposed at a later if development activities demonstrate the economic feasibility of doing so in the future. To bring in electrical service to the area would require construction of many miles of above ground power lines, the construction of substations and interior lines to centralized POD facilities. The likelihood of this action ever occurring would depend on which areas produce enough gas, their geographic relationship to each other, and the available technology to deliver the power. At this time there isn't enough information to determine what such a proposal will look like, or where it will be located. Any powerline proposals for above ground electrical distribution would require an additional NEPA analysis, either in the form of an EIS or EA, depending at least in part on the nature and extent of the proposal.

K.1.3.3Pipelines

Three types of pipelines would be constructed as part of the proposed Project:

1. Gas-gathering pipeline systems (low pressure, from wellhead to Central Compressor Station).

2. Produced water-gathering pipeline systems (low pressure, from wellhead to centralized conditioning facilities or injection facilities).

3. Gas-delivery pipelines (high pressure, from compressor station to existing transmission pipelines).

Reclamation of pipeline corridors would occur as soon as practical after pipeline construction is complete.

K.1.3.3.1 Gas-Gathering Pipeline Systems

Gas-gathering and produced water-gathering pipelines would be placed together in the same trench/ditch when practical. Construction and installation of pipelines would occur immediately

upon determination of the well's capability to produce. The pipeline ROW would typically follow access roads, except in a limited number of cases where topography dictates or as required by the BLM. Separate gathering lines would be used to transport gas to production facilities and/or compressor stations and produced water to central conditioning facilities and/or injection facilities. Gathering lines average 2,640 feet in length (per productive well) and 30 feet in width after construction.

K.1.3.3.2 Produced-Water Gathering System and Disposal Facilities

The outcome of the Atlantic Rim Project will depend, in part, on the economical disposal of water produced in association with dewatering of CBNG. Produced water would primarily be disposed of by injection into a suitable aquifer via injection well (anywhere in the ARPA).

Predictions for water disposal volumes indicate that a minimum of one water disposal facility would be needed for each POD (12 wells/POD) in the early stages of field development. A water disposal facility would initially consist of one re-injection well, four fiberglass storage tanks, pump station, and a dehydration unit. A CBNG well would initially produce approximately 800 barrels of water per day and steadily decline to 10 barrels per day in three years.

Produced water-gathering pipelines would be constructed along the well access road wherever feasible, from the wellhead to the central conditioning/storage facilities. The water lines would be placed together in the same trench/ditch as gas gathering lines wherever practical, and buried. Both, typical water conditioning facility and a water disposal facility are shown in Figure K-7.

Transfer pumping stations would be used during production operations to transfer produced water from the CBNG well(s) to the injection facilities or the water conditioning sites. The transfer pumping stations are needed in those areas where elevation differences require supplemental pumping to transfer the produced water. If transfer pumping stations are required, they would be identified in the individual APDs or MSUP. Each pumping station would contain a

400-barrel water tank, an inlet separation vessel, and a small centrifugal water pump. Each pumping station would consist of a pad area having approximate dimensions of 100 feet by 100 feet, and disturbing an estimated 0.2 acre. An approximate two-foot berm would be constructed around the perimeter of each pumping station area to contain any potential water spills. A small pump house would be constructed immediately outside the bermed area to house the centrifugal pump. A typical water transfer facility is shown in Figure K-8.

K.1.3.3.2.1 Surface Disposal

No surface disposal is proposed. Limited use of closed livestock and wildlife watering systems may occur, but will not be used to dispose of produced water.

K.1.3.3.2.2 Subsurface Disposal

Subsurface disposal of produced water would be used in the ARPA. Produced water from individual wells would be gathered and routed to centralized water handling and storage sites, which would serve as central injection facilities (Figure K-7). The centralized facilities would be approved, as required, by the BLM, WOGCC, SEO, and WDEQ and would each be located offsetting injection or re-injection well(s). Facilities would location share wherever possible.

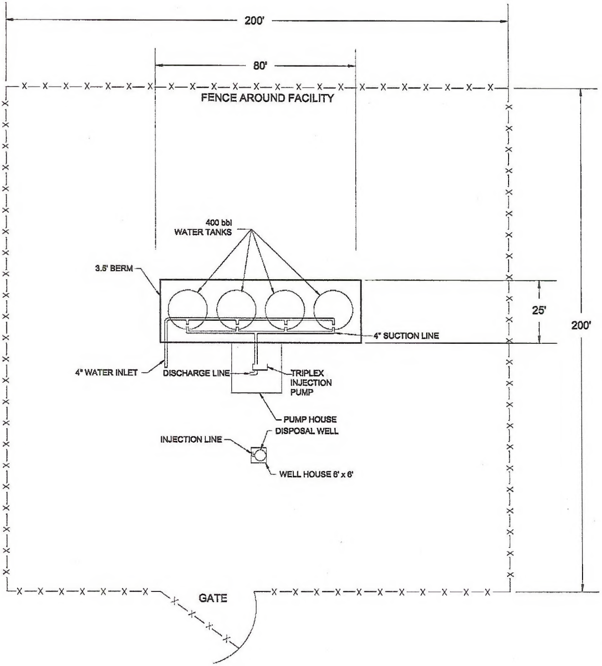


Figure K-7. Typical Water Conditioning and Disposal Facility – Atlantic Rim Natural Gas Project.

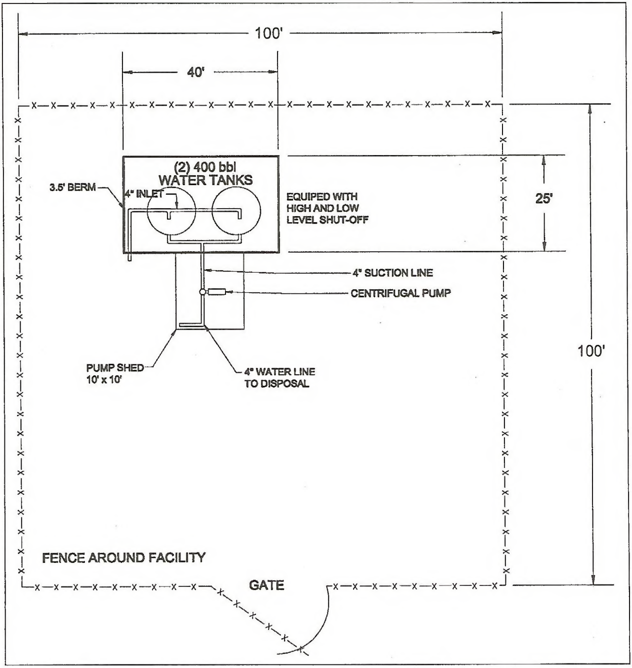


Figure K-8. Typical Water Transfer Facility – Atlantic Rim Natural Gas Project.

Formations targeted for injection of produced water are shown in Table K-1, based upon interim POD information.

Each deep injection well would have an approximate minimum injection capacity of 5,000 bbls/day and maximum injection capacity of 15,000 bbls/day. A predicted total project volume of produced water in the best success scenario for the proposed well development would be 250,000 to 450,000 bbls/day for approximately six to eight years. The volume of water would be on a consistent decline as the coal seam is dewatered. The above projections reflect water being produced during the exploration phase and water that could be produced if 2,000 wells were being dewatered simultaneously. 2,000 wells would result in approximately 166 injection wells.

Table K-1. Produced Water Injection Target Formations.

Formation	Depth Below Surface, Feet	POD Reference
Hatfield	5,965 to 6,335	Red Rim
Cherokee	5,965 to 6,335	Red Rim
Deep Creek Sandstone	5,965 to 6,335	Red Rim
Cherokee	3,200	Sun Dog, Brown Cow
Deep Creek Sandstone	3,400	Sun Dog, Brown Cow
Cherokee Sandstone	3,900 to 4,400	Blue Sky
Deep Creek Sandstone	4,200 to 4,700	Blue Sky

K.1.3.3.3 Gas-Delivery Pipelines and Compression

Produced natural gas under wellhead pressure would move through the low pressure gas gathering system to a compressor station. Typical gathering system line pressure is less than 100 pounds per square inch (psi). Gas arriving at the compressor station would be compressed from gathering line pressures up to higher pressures to facilitate gas delivery into a transmission pipeline.

Compression of the gas at a field compressor station would increase the pressure to an estimated 700 to 1,440 psi. The compressor station would have a pad size of 300 feet by 300 feet and would result in approximately 2.1 acres of site disturbance. All compressors are expected to be housed within structures. A typical compressor station is shown in Figure K-9.

Total compression needs for the Proposed Action would be 42,000 hp to 52,000 hp. The Operators estimate that a total of 61 compressor stations would be required for implementation of the Proposed Action. Engine make and model would vary due to compression requirements of the field gas. Initial compression is projected to be natural gas engine driven reciprocating compressor units meeting best available control technology (BACT) requirements of WDEQ-AQD. Each compressor station would also have a 1,206 hp natural gas fired generator (Cat 3516TA rich-burn with NSCR catalyst) for electric power production. Once electric power is available on-site compression would change over to electrically driven.

K.1.3.4 Ancillary Facilities

All wells, pipelines, and associated ancillary production facilities would be operated in a safe manner by the Operators, as set forth by standard industry operating guidelines and procedures. Routine maintenance of producing wells would be necessary to maximize performance and detect potential difficulties with gas production operations. Each well location would be visited about every other day to ensure operations are proceeding in an efficient and safe manner. The visits would include checking gauges, valves, fittings, and onsite storage of produced water. Routine onsite equipment maintenance would also be performed as necessary. Additionally, all roads and well locations would be regularly inspected and maintained to minimize erosion and assure safe operating conditions.

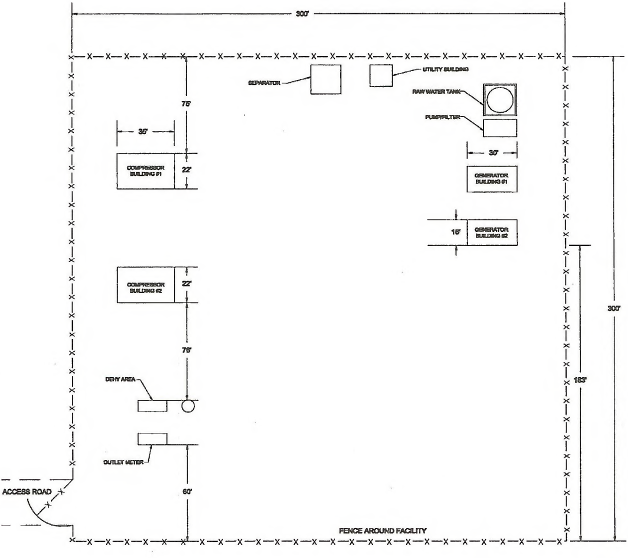


Figure K-9. Typical Compression Facility – Atlantic Rim Natural Gas Project.

K.1.3.5Traffic and Work Force Estimates

Estimated traffic requirements for drilling, completion, and field development operations are shown in Table K-2. The 'Trip Type' column lists the various service and supply vehicles that would travel to and from the well sites and production facilities. The 'Round-Trip Frequency' column lists the number of trips, both external (i.e., to/from the Project Area) and internal (within the Project Area). The figures provided in Table K-2 should be considered general estimates. Drilling and production activity levels may vary over time in response to weather and other factors.

Table K-2. Traffic Estimates.

Trip Type	Round-Trip Frequency	
Drilling (2 rigs, 2 crews/rig)	**External (to/from Project Area)**	**Internal (within Project Area)**
Rig supervisor	4/day	same
Rig crews	4/day	same
Engineers [a]	2/week	1/day/rig
Mechanics	4/week	same
Supply delivery [b]	1/week	2-4/day
Water truck [c]	3/week	2 round trips/day
Fuel trucks	4 round trips/well	same
Mud trucks [d]	1/week	2/day
Rig move [e]	8 trucks/well	8 trucks/well
Drill bit/tool delivery	2/ weeks	same
Completion		
Small rig/crew	1/day	same
Cement crew	2 trips/well	same
Consultant	1/day	same
Well loggers	3 trips/well	same
Gathering systems	2/day	same
Power systems	2/day	same
Compressor stations	2/day	same
Other field development	2/day	same
Testing and operations	2/day	same

Notes:

[a] Engineers travel to Project Area weekly and stay in a trailer at the Project Area during the week.
[b] Current plans are to establish a central supply area within a Project Area and deliver supplies on a weekly basis.
[c] Water trucks would deliver water to rigs from a location within the Project Area.
[d] Current plans are to establish a central mud location within a Project Area and deliver mud on a weekly basis.
[e] It would require eight trucks to move each rig to a Project Area. Upon completion of drilling in a Project Area, each rig would move to the next Project Area.

K.1.3.6 Site Restoration and Abandonment

The Operators propose to completely reclaim in the interim all disturbed areas not needed for production activities. Reclamation would generally include: 1) complete cleanup of the disturbed areas (drill sites, access roads, etc.), 2) restoration of the disturbed areas to the approximate ground contour that existed prior to construction, 3) replacement of topsoil over all disturbed areas, 4) ripping of disturbed areas to a depth of 12 to 18 inches, and 5) seeding of re-contoured areas with a BLM approved, certified weed-free, seed mixture.

Specific reclamation recommendations for use with the natural gas drilling and production operations within the project area are described in the Reclamation Plan (Appendix B). The final set of reclamation measures to be applied would be developed in the APD or ROW grant by each operator in consultation with the BLM and would be specific to each site and the conditions at that site.

K.1.3.7 Applicant Voluntarily Committed Measures

Following are applicant committed measures to avoid or mitigate resource or other land use impacts. An exception to a mitigation measure and/or design feature may be approved on a case-by-case basis when deemed appropriate by the BLM or in conjunction with the surface owner. An exception would be approved only after a thorough, site-specific analysis determined that the resource or land use for which the measure was put in place is not present or would not be significantly impacted. The Operators propose to implement resource-specific mitigation measures on all lands within the ARPA including federal, State and private (fee) surface ownership:

K.1.3.7.1 Preconstruction Planning and Design Measures

The Operators and the BLM would make on-site Interdisciplinary (ID) reviews of each proposed and staked facility site (e.g., well sites), new access road, access road reconstruction, and pipeline alignment projects so that site-specific recommendations and mitigation measures can be developed.

- New road construction and maintenance of existing roads in the ARPA would be accomplished in accordance with BLM Manual 9113 standards unless private landowners or the State of Wyoming specify otherwise on their lands.

- Consistent with the annual work planning described in section K.1.1, The Operators would prepare and submit an APD for each drill site on federal leases to the BLM for approval prior to initiation of construction. Also prior to construction, the Operators or their contractors would submit a Sundry Notice and/or ROW application for each pipeline and access road segment on federal leases. The APD would include a Surface Use Plan that would show the layout of the drill pad over the existing topography, dimensions of the pad, volumes and cross sections of cut and fill, location and dimensions of reserve pit, and access road egress and ingress. The APD, Sundry Notice, and/or ROW application plan would also itemize project administration, time frame, and responsible parties. In addition, a reclamation plan would be developed by the operators for each facility in consultation with the BLM. APD packages would be submitted annually on

April 1, including GIS data specified in K.1.1, for planning and analysis for the upcoming work year.

K.1.3.7.2 Resource-Specific Requirements

Geology/Minerals

Mitigation measures presented in the Soils and Water Resources sections would avoid or minimize many of the potential impacts to the surface mineral resources. Protection of subsurface mineral resources from adverse impacts would be provided by the BLM and/or WOGCC casing and cementing policy.

Climate and Air Quality

- The Operators would not burn garbage or refuse at the drill sites or other facilities.
- When an air quality, soil loss, or safety problem is identified as a result of fugitive dust, immediate abatement would be initiated.

Soils and Water Resources

- Reduce the area of disturbance to the absolute minimum necessary for construction and production operations while providing for the safety of personnel. The Operators would prohibit off-road vehicle activity.
- Generally, buried pipelines would be located immediately adjacent to roads to avoid creating separate areas of disturbance and in order to reduce the total area of disturbance.
- The operators would avoid using frozen or saturated soils as construction material.
- The operators would minimize construction activities in areas of steep slopes and other sensitive soils, and apply special slope stabilizing structures if construction cannot be avoided in these areas.
- Design cut slopes in a manner that would allow retention of topsoil, surface treatment such as mulch, and subsequent revegetation.
- Selectively strip and salvage topsoil or the best suitable medium for plant growth from all disturbed areas on all well pads.
- Where possible, minimize disturbance to vegetated cuts and fills on existing roads that are improved.
- Install runoff and erosion control measures such as water bars, berms, and interceptor ditches if needed.
- Implement minor routing variations during access road layout to avoid steep slopes adjacent to ephemeral or intermittent drainage channels. Maintain a buffer strip of natural vegetation where possible (not including wetland vegetation) between all construction activities and ephemeral and intermittent drainage channels.

- Include adequate drainage control devices and measures in the road design (e.g., road berms and drainage ditches, diversion ditches, cross drains, culverts, out-sloping, and energy dissipaters) at sufficient intervals and intensities to adequately control and direct surface runoff above, below, and within the road environment to avoid erosive concentrated flows. In conjunction with surface runoff or drainage control measures, use erosion control devices and measures such as temporary barriers, ditch blocks, erosion stops, mattes, mulches, and vegetative covers. Implement a revegetation program as soon as possible to re-establish the soil protection afforded by a vegetal cover.

- Upon completion of construction activities, restore topography to near pre-existing contours at the well sites, along access roads and pipelines, and other facilities sites. Replace topsoil or suitable plant growth material over all disturbed surfaces, and apply fertilizer as needed, and seed.

- When feasible, limit construction of drainage crossings to no-flow periods or low-flow periods.

- Minimize the area of disturbance within ephemeral and intermittent drainage channel environments.

- Avoid construction of well sites, access roads, and pipelines within 500 feet of surface water and/or riparian areas. Exceptions to this would be granted by the BLM based on an environmental analysis and site-specific mitigation plans.

- Design channel crossings to minimize changes in channel geometry and subsequent changes in flow hydraulics.

- Construct channel crossings for buried pipelines such that the pipe is buried a minimum of four feet below the channel bottom.

- Regrade disturbed channel beds to the original geometric configuration with the same or very similar bed material.

- Case wells during drilling, and case and cement all wells in accordance with State, and/or Federal regulations to protect accessible high quality aquifers. High quality aquifers are aquifers with known water quality of 10,000 ppm TDS or less. Include well casing and welding of sufficient integrity to contain all fluids under high pressure during drilling and well completion. Further, wells would adhere to the appropriate BLM or WOGCC cementing policy.

- Reserve pits would be constructed so that a minimum of one-half of the total depth is below the original ground surface on the lowest point within the pit. To prevent seepage of fluids, drilling mud gel or poly liners would be used as needed to line reserve pits in areas where subsurface material would not contain fluids. Liners would be of sufficient strength and thickness to withstand normal installation and use. The liner would be impermeable (i.e., having a permeability of less than 10^{-7} cm/sec) and chemically compatible with all substances which may be put in the pit.

- Maintain 2 feet of freeboard on all reserve pits to ensure the reserve pits are not in danger of overflowing. Shut down drilling operations until the problem is corrected if leakage is found outside the pit.

- Extract hydrostatic test water used in conjunction with pipeline testing and all water used during construction activities from sources with sufficient quantities and through appropriation permits approved by the State of Wyoming.

- Discharge hydrostatic test water in a controlled manner onto an energy dissipator. The water is to be discharged onto undisturbed land that has vegetative cover, if possible, or into an established drainage channel. Prior to discharge, treat or filter the water to reduce pollutant levels or to settle out suspended particles if necessary. If discharged into an established drainage channel, the rate of discharge would not exceed the capacity of the channel to safely convey the increased flow. Coordinate all discharge to test water with the SEO and the BLM.

- Develop and implement a Storm Water Pollution Prevention Plan (SWPPP) for storm water runoff at drill sites as required per WDEQ storm water NPDES permit requirements.

- The Operators must coordinate with the Corps of Engineers (COE) to determine the specific Clean Water Act (CWA) Section 404 Permit requirements and conditions (including the potential requirement of compensatory mitigation) for each facility that occurs in Waters of the U.S. to prevent the occurrence of significant impact to such waters.

- Exercise precautions against pipeline breaks and other potential accidental discharges of toxic chemicals into adjacent streams. If liquid petroleum products storage capacity exceeds criteria contained in 40 CFR Part 112, a Spill Prevention Control and Countermeasures (SPCC) plan would be developed in accordance with 40 CFR Part 112.

- The project must comply with all applicable requirements of the CWA, including the requirement to obtain an WYPDES permit.

Vegetation and Wetlands

- Seed and stabilize disturbed areas with mixtures and treatment guidelines prescribed in the approved APD, ROW, or surface landowner requirements.

- Evaluate all project facility sites for occurrence and distribution of waters of the U.S., special aquatic sites, and jurisdictional wetlands. All project facilities would be located out of these sensitive areas. If complete avoidance is not possible, minimize impacts through modification and minor relocations. Coordinate activities that involve dredge or fill into wetlands with the COE.

- Conduct site-specific surveys for federally listed threatened and endangered (T&E) and candidate plant species prior to any surface disturbance in accordance with the Endangered Species Act.

Range Resources and Other Land Uses

- The Operators would coordinate with the affected livestock operators to ensure that livestock control structures remain functional during drilling and production operations.

Wildlife

- During reclamation, establish a variety of forage species that are useful to resident herbivores by specifying the seed mixes in the approved APD, ROW or surface landowner requirements.

- Discourage unnecessary off-site activities of operational personnel in the vicinity of the drill sites.

Visual Resources

- Paint all structures with non-reflective colors that blend with the adjacent landscape, except for structures that require safety coloration in accordance with Occupational Safety and Health Administration (OSHA) requirements.

Cultural Resources

- If a site is considered eligible for, or is already on the National Register of Historic Places (NRHP), avoidance is the preferred method for mitigating adverse effects to that property.

Socioeconomics

- Coordinate project activities with ranching operations to minimize conflicts involving livestock movement or other ranch operations. This would include scheduling of project activities to minimize potential disturbance of large-scale livestock movements. Establish effective and frequent communication with affected ranchers to monitor and correct problems and coordinate scheduling.

Health and Safety

- The operators will establish and maintain an appropriate safety program for the intended work which will comply with all applicable Federal, State and local regulations, including but not limited to, RCRA, SPCC, SARA, Hazardous Substance Management.

Table K-3. Types and Approximate Acreage of Surface Disturbance by Surface Ownership of the Proposed Action.

Proposed Action									
Atlantic Rim Project Disturbance - Acres									
	Life of Project Disturbance					Initial Disturbance			
Type	Federal	Private	State	Total		Federal	Private	State	Total
Coalbed NG	1,152	558	90	1,800		2,304	1,116	180	3,600
Conventional NG	333	161	26	520		564	273	44	882
Total Wellpad	1,485	719	116	2,320		2,868	1,389	224	4,482
Roads / Utilities*	2,327	1,127	182	3,636		6,206	3,006	485	9,697
Pipelines	0	0	0	0		93	45	7	145
Ancillary Facilities	182	88	14	285		947	458	74	1,479
Totals	3,994	1,935	312	6,241		10,114	4,899	790	15,803

Assumptions Used to Calculate the Proposed Action Distrubance Acreage

Assumptions	Amount	Unit		Assumptions	Amount	Unit
Acres / well pad Short Term -Coal Bed	2	Acres		Coal Bed NG Wells	1800	Wells
Acres / well pad Long Term - Coal Bed	1	Acres		Conventional NG Wells	200	Wells
Acres disturbance / well pad Short Term -Conventional	4.41	Acres		Total Number of Wells Analyzed	2000	Wells
Acres disturbance / well pad Long Term -Conventional	2.6	Acres		% Federal Development	64	%
Drilling Success Rate	100	%		% Private Development	31	%
Miles / Well pad, avg*	0.5	Miles		% State of Wyoming Development	5	%
Disturbance width, Roads & Utilities - initial	80	Feet		Ancillary Facilities - initial disturbance	1479	Acres
Disturbance Width, Roads & Utilities - LOP	30	Feet		Ancillary Facilities - LOP disturbance	285	Acres
Pipelines Outside Road Corridors	15	Miles				

*well pad roads, collector roads and new arterial roads are considered in this figure.

Other than the asterisked number, all numbers (averages) used in the assumption chart are taken from actual field inspections conducted the summer of 2005 for both CBNG and conventional gas wells (BLM, 2005).

Appendix M

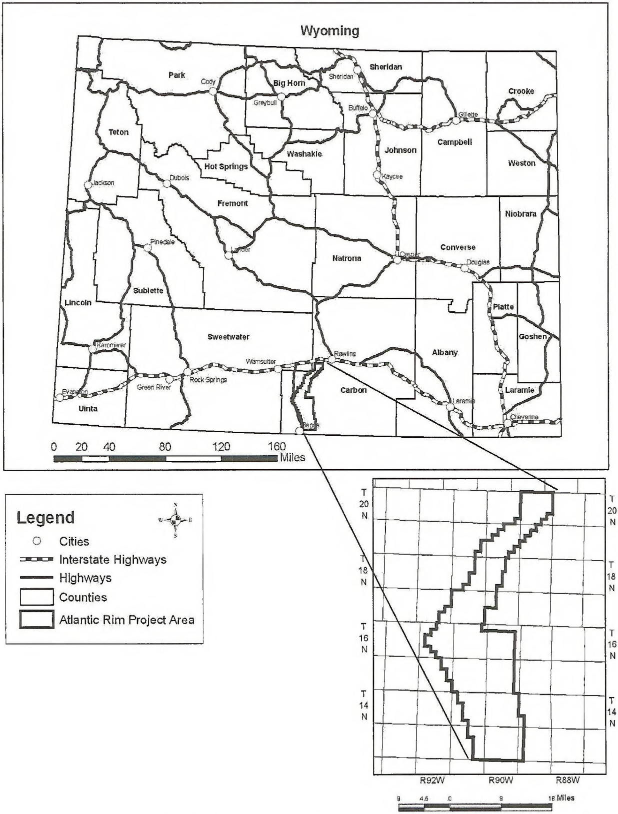
MAPS

This appendix contains maps referenced throughout the document and serves as a visual reference. The Bureau of Land Management shall not be held liable for improper or incorrect use of this data, based on the description of appropriate/inappropriate use described in this document. The distributor makes no claim for the data's suitability for other purposes.

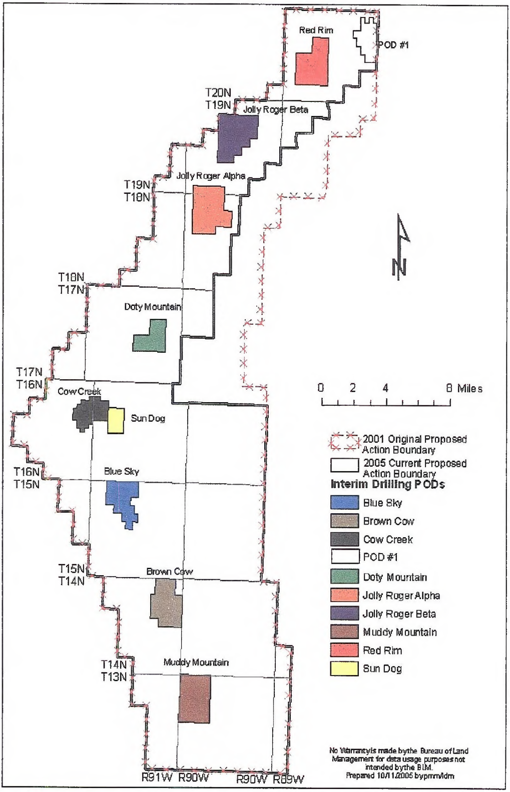
Appendix M – MAPS

List of Maps

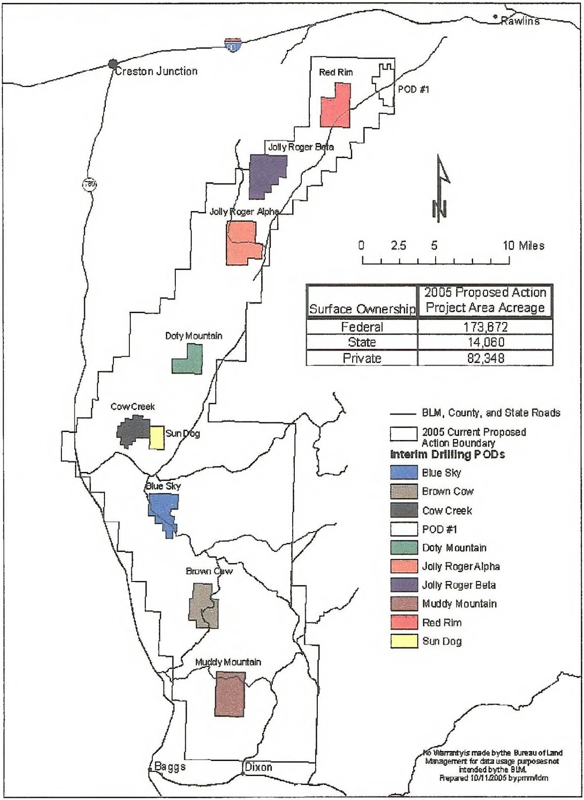
ATLANTIC RIM DRAFT EIS MAP
Project Area Map



ATLANTIC RIM DRAFT EIS
2001 Project Area

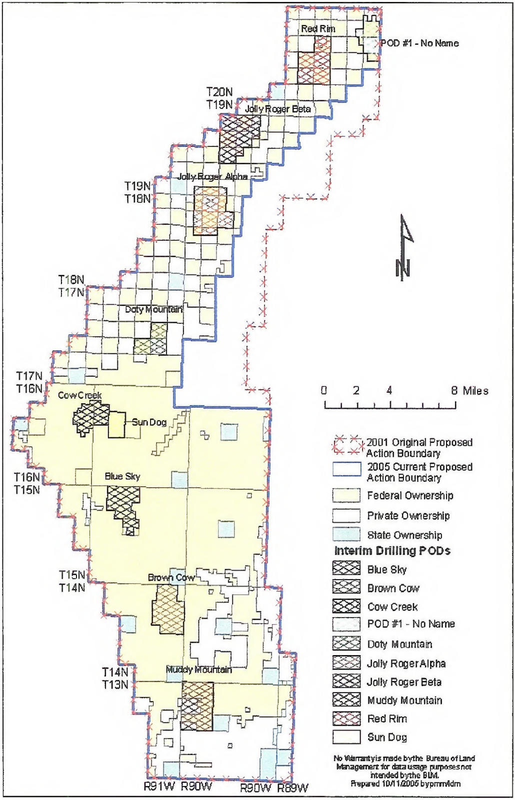


ATLANTIC RIM DRAFT EIS MAP
2005 Proposed Action Project Area

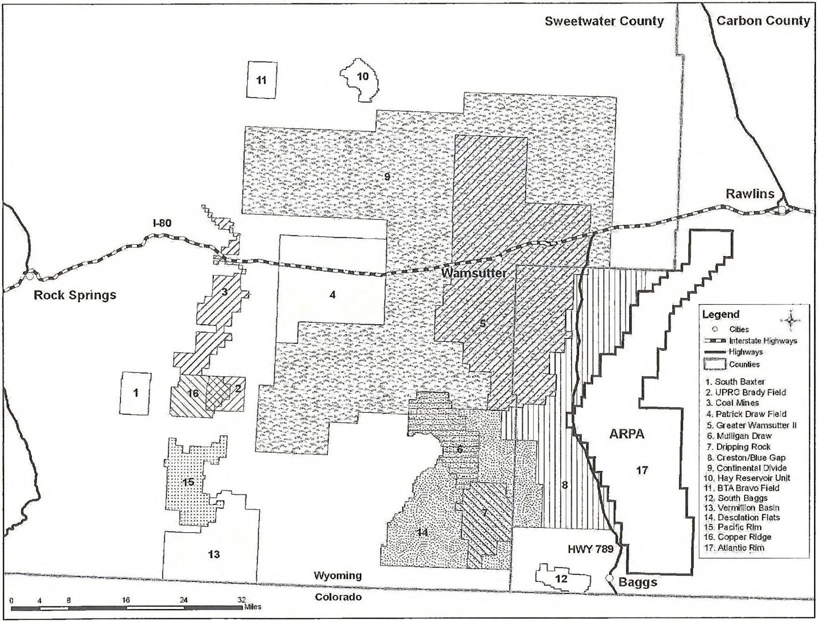


Surface Ownership	2005 Proposed Action Project Area Acreage
Federal	173,872
State	14,060
Private	82,348

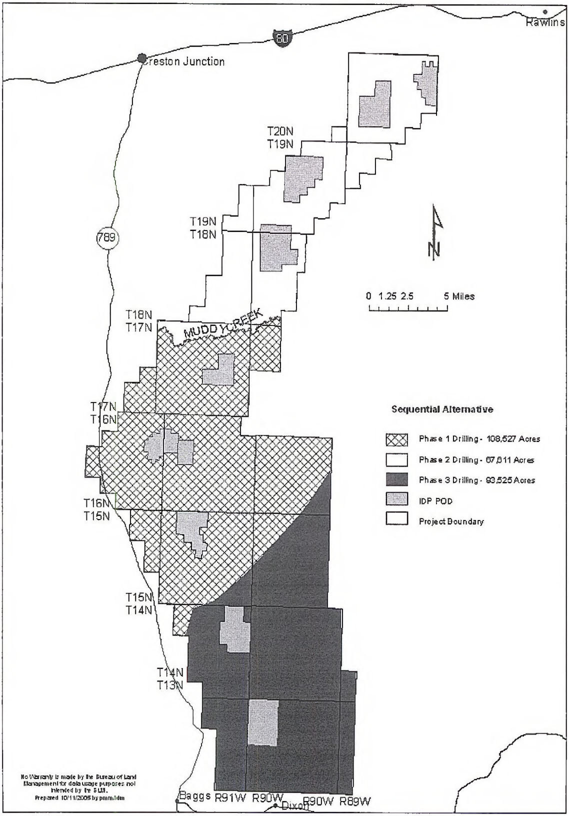
ATLANTIC RIM DRAFT EIS
Ownership



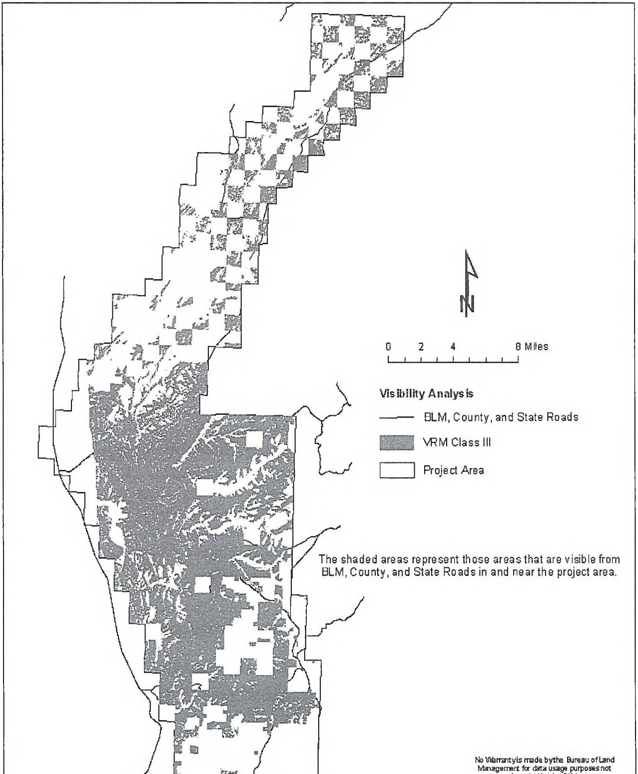
ATLANTIC RIM DRAFT EIS MAP
Mineral Development Projects in the Vicinity



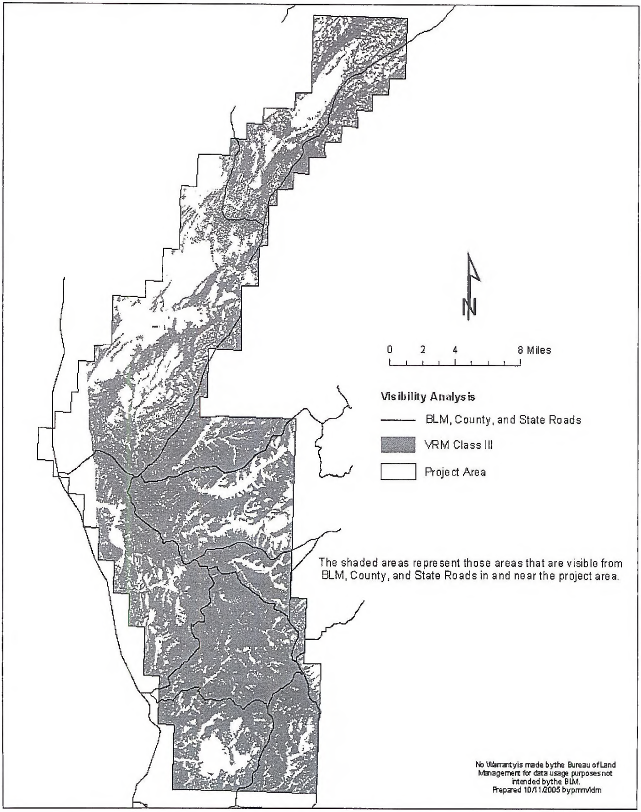
ATLANTIC RIM DRAFT EIS MAP
Alternative B - Phases of Drilling and Drilling PODs



ATLANTIC RIM DRAFT EIS
Areas Visible from Main Roads in VRM Class III

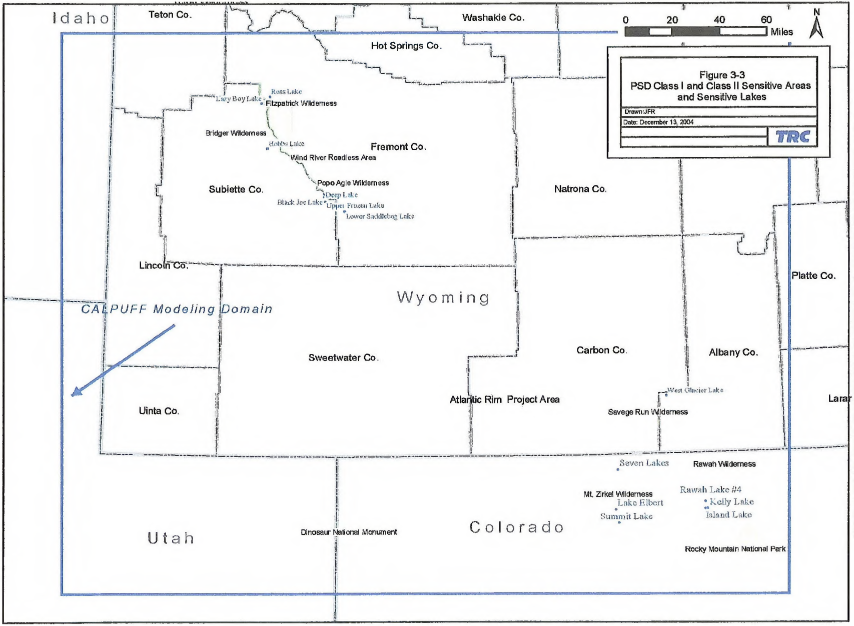


ATLANTIC RIM DRAFT EIS
Areas Visible from Main Roads in VRM Class III

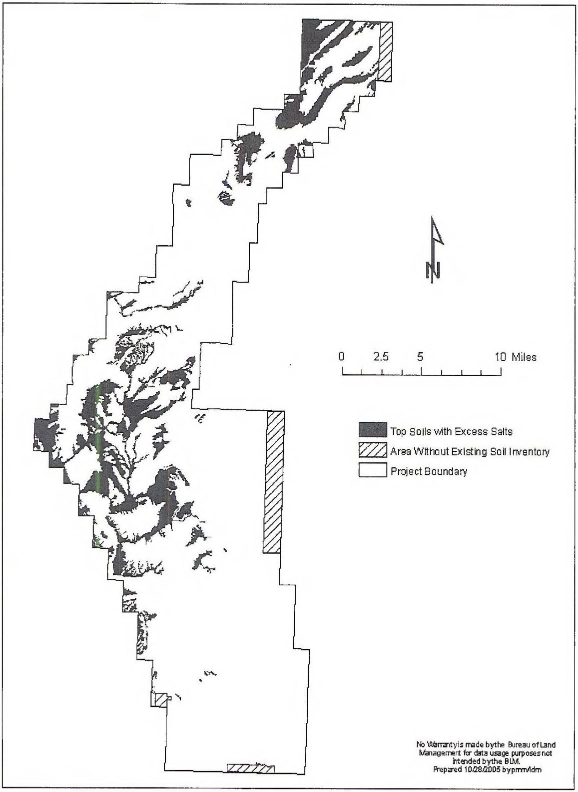


ATLANTIC RIM DRAFT EIS MAP

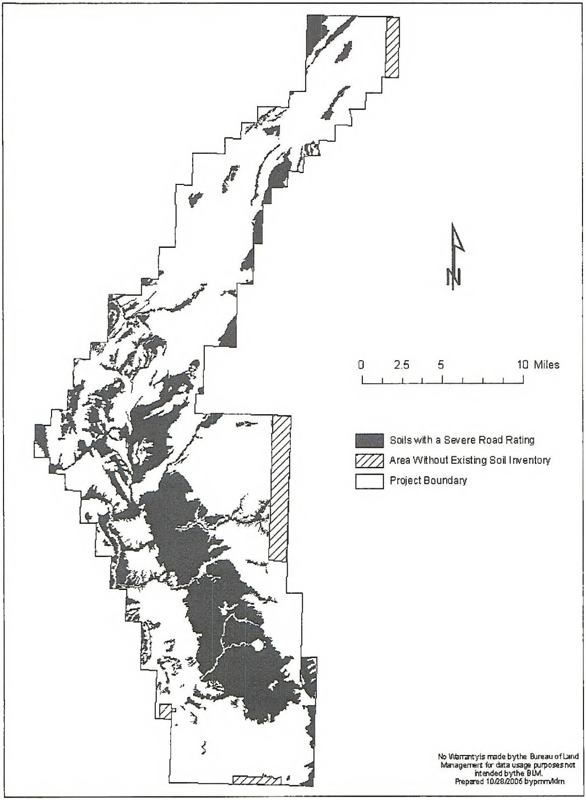
PSD Class I and Class II Sensitive Areas and Sensitive Lakes



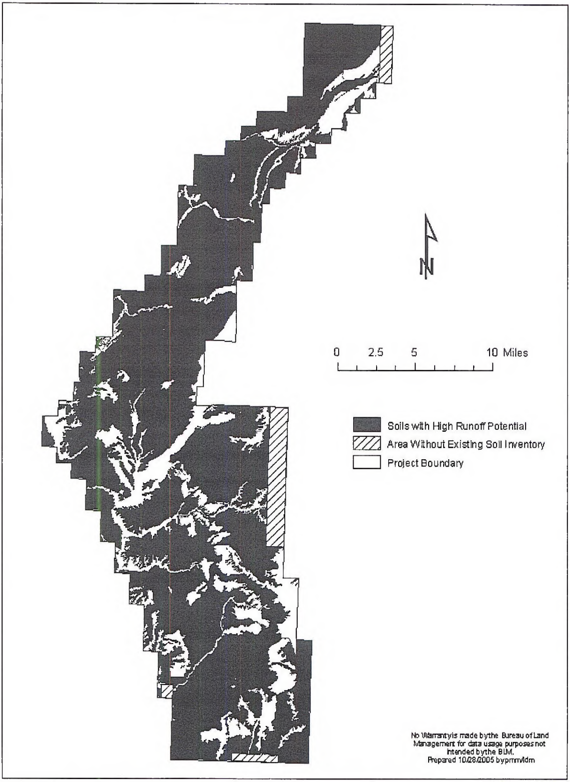
ATLANTIC RIM DRAFT EIS MAP
Top Soils with Excess Salts



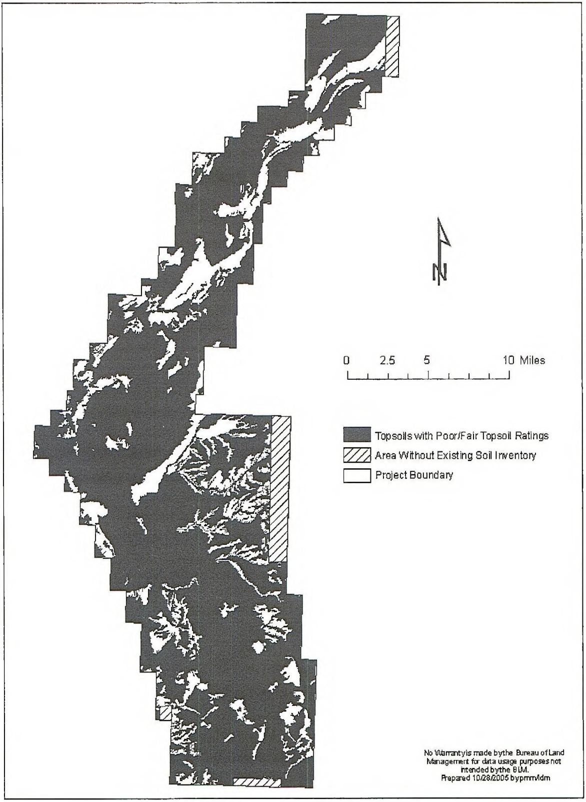
ATLANTIC RIM DRAFT EIS MAP
Soils with a Severe Road Rating



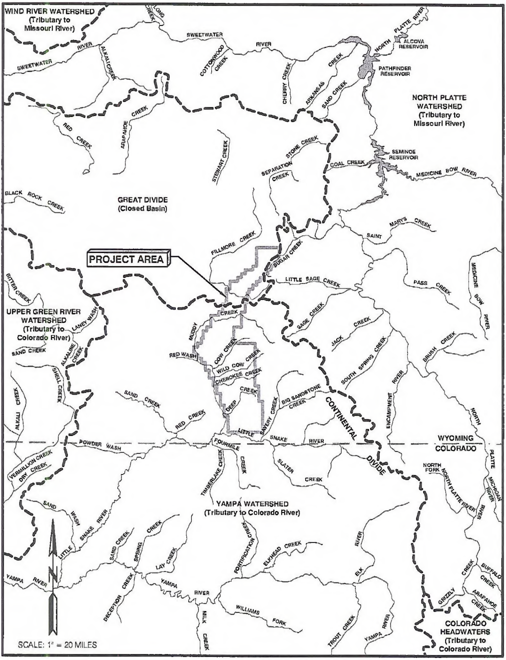
ATLANTIC RIM DRAFT EIS MAP
Soils with High Runoff Potential



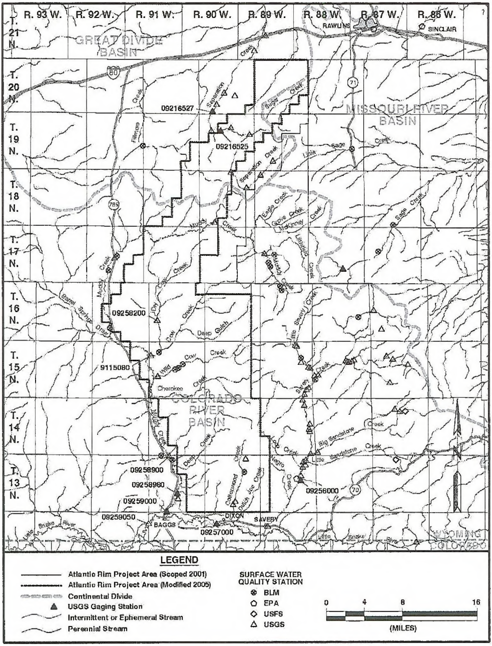
ATLANTIC RIM DRAFT EIS MAP
Soils with Poor/Fair Topsoil Ratings



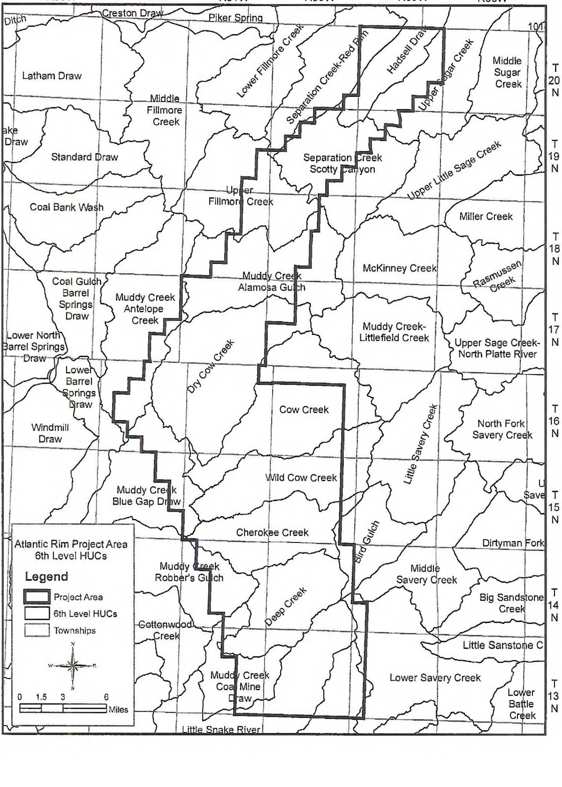
ATLANTIC RIM DRAFT EIS MAP
Watershed Basins



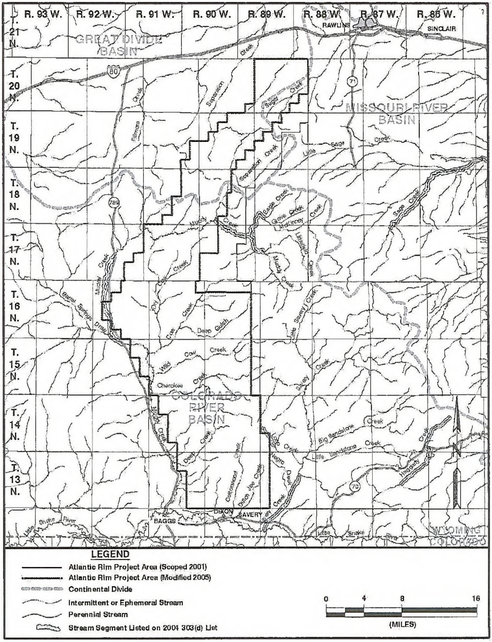
ATLANTIC RIM DRAFT EIS MAP
Surface Waters and Monitoring Stations



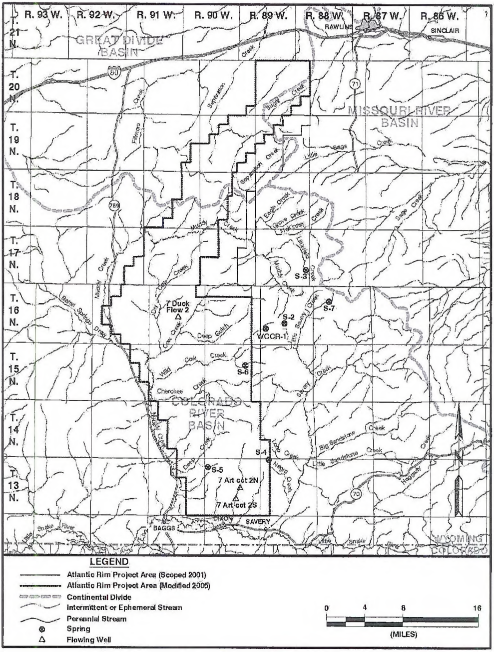
ATLANTIC RIM DRAFT EIS MAP
Hydrologic Unit Code Boundaries

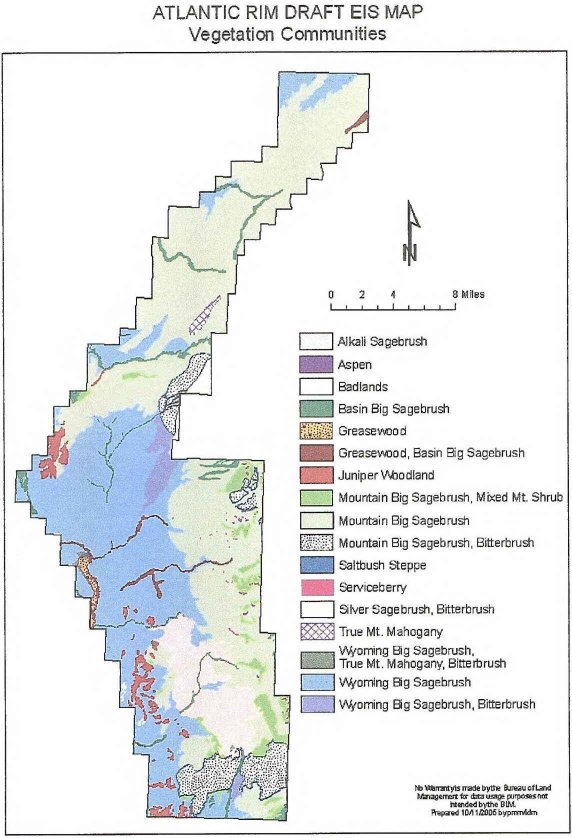


ATLANTIC RIM DRAFT EIS MAP
Threatened or Impaired Streams

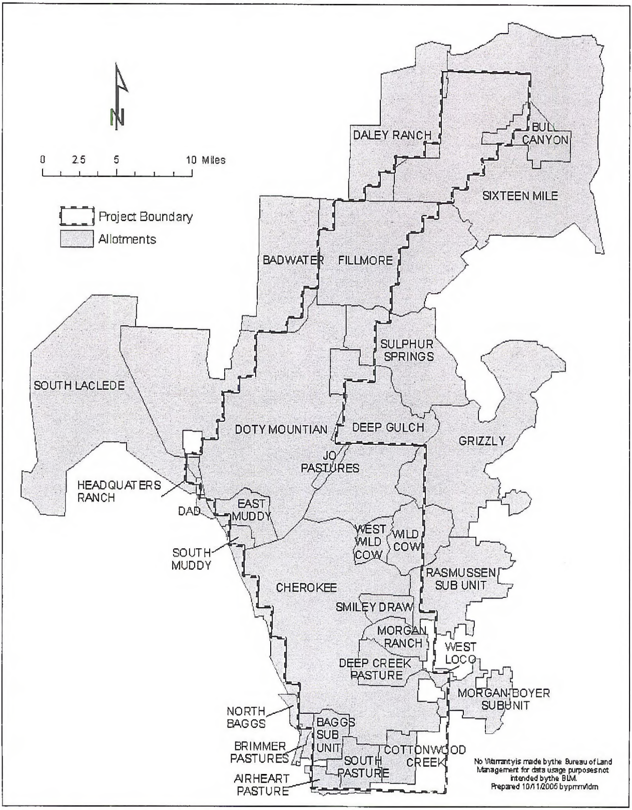


ATLANTIC RIM DRAFT EIS MAP
Sampled Springs and Flowing Wells

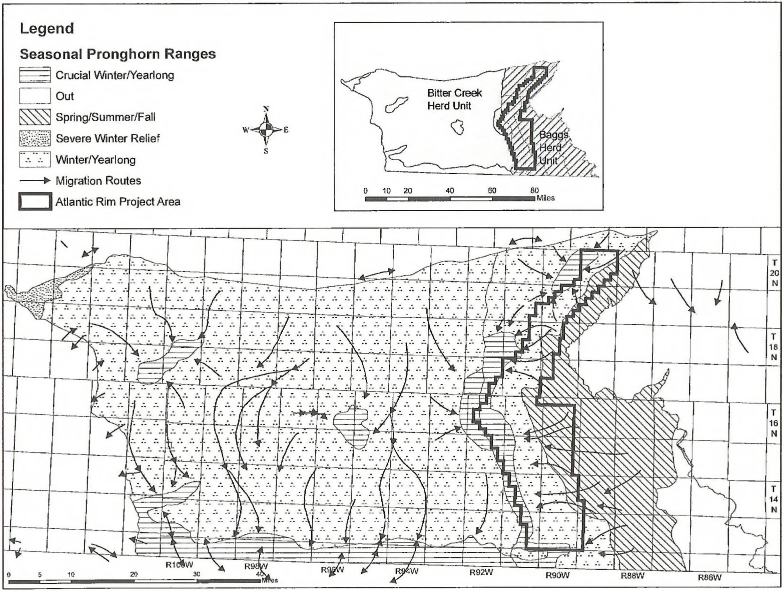



ATLANTIC RIM DRAFT EIS MAP
Vegetation Communities
N
0 2 4 8 Miles
Alkali Sagebrush
Aspen
Badlands
Basin Big Sagebrush
Greasewood
Greasewood, Basin Big Sagebrush
Juniper Woodland
Mountain Big Sagebrush, Mixed Mt. Shrub
Mountain Big Sagebrush
Mountain Big Sagebrush, Bitterbrush
Saltbush Steppe
Serviceberry
Silver Sagebrush, Bitterbrush
True Mt. Mahogany
Wyoming Big Sagebrush, True Mt. Mahogany, Bitterbrush
Wyoming Big Sagebrush
Wyoming Big Sagebrush, Bitterbrush
No Warranty is made by the Bureau of Land Management for data usage purposes not intended by the BLM.
Prepared 10/11/2006 by pmm/ldm

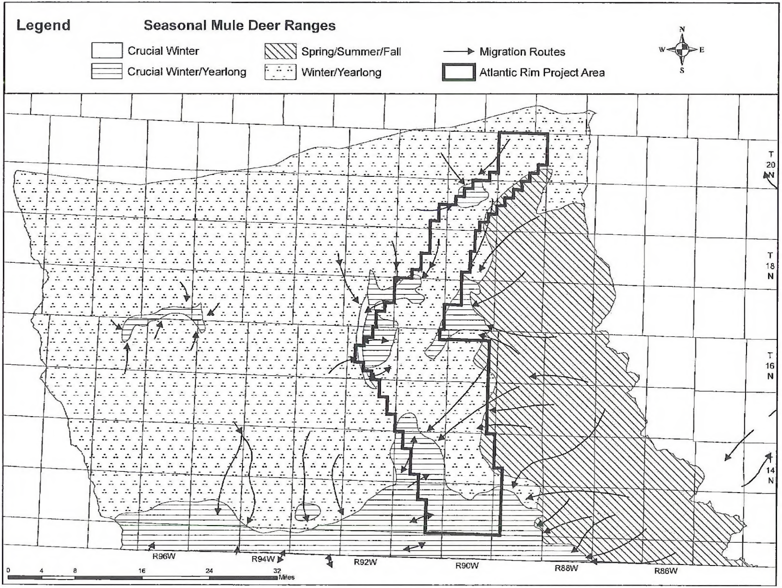
ATLANTIC RIM DRAFT EIS MAP
Grazing Allotments



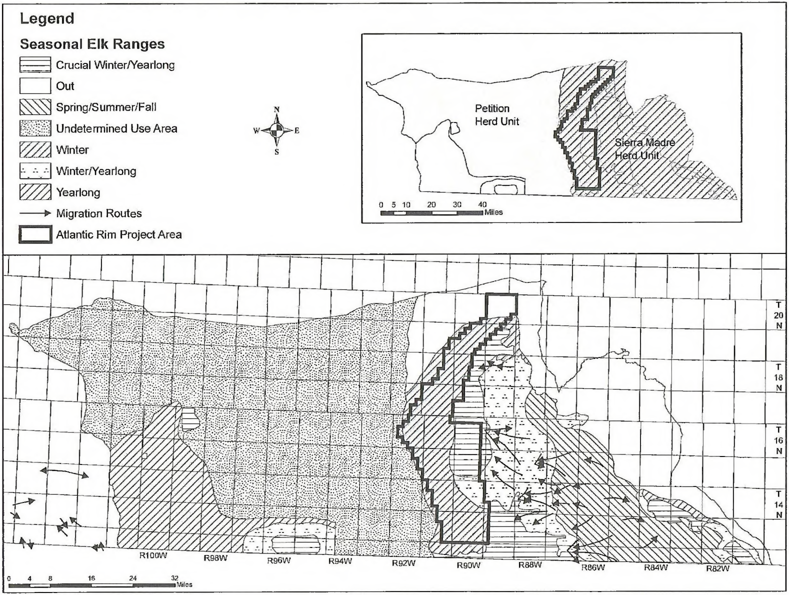
ATLANTIC RIM DRAFT EIS MAP
Seasonal Pronghorn Ranges and Migrations Routes



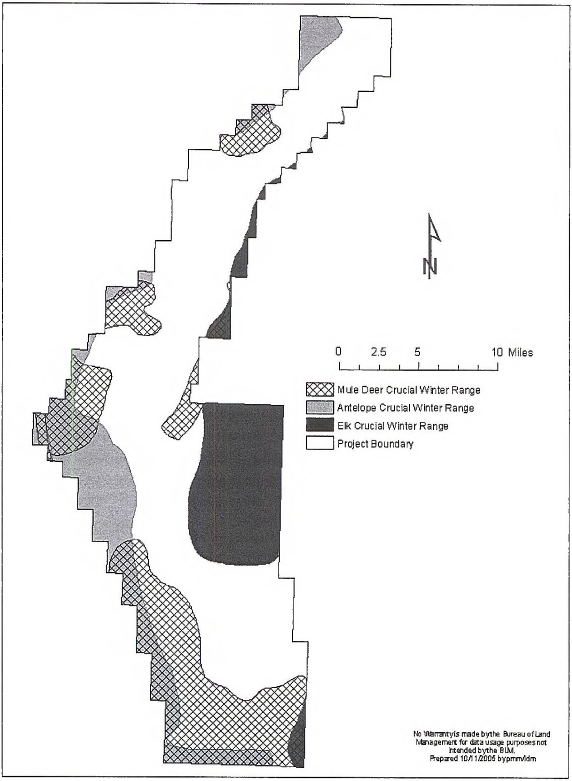
ATLANTIC RIM DRAFT EIS MAP
Seasonal Mule Deer Ranges and Migrations Routes



ATLANTIC RIM DRAFT EIS MAP
Seasonal Elk Ranges and Migrations Routes

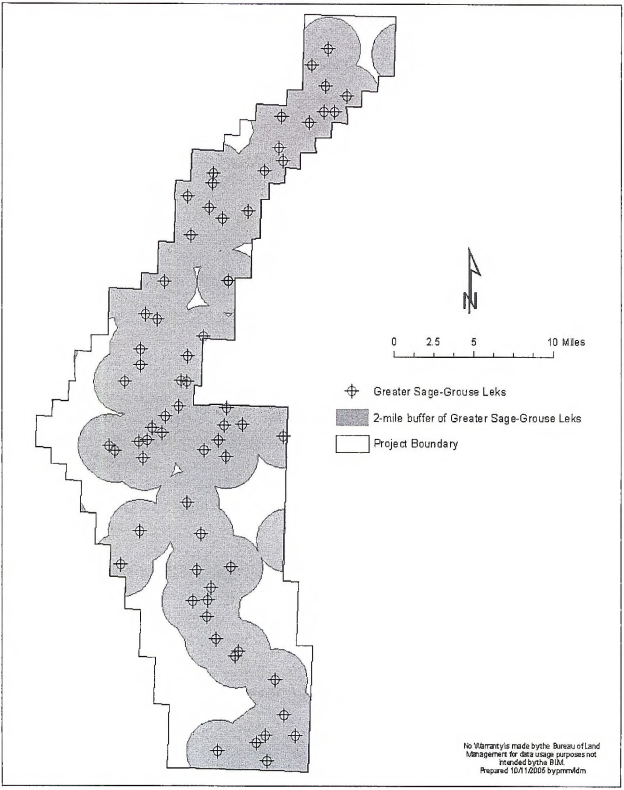


ATLANTIC RIM DRAFT EIS MAP
Big Game Crucial Winter Ranges

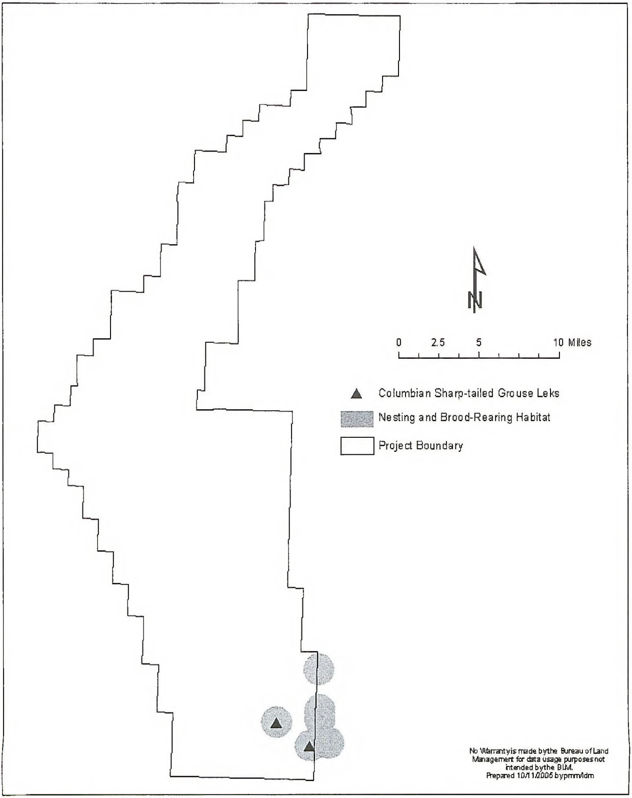


ATLANTIC RIM DRAFT EIS
Overlapping Crucial Winter Ranges

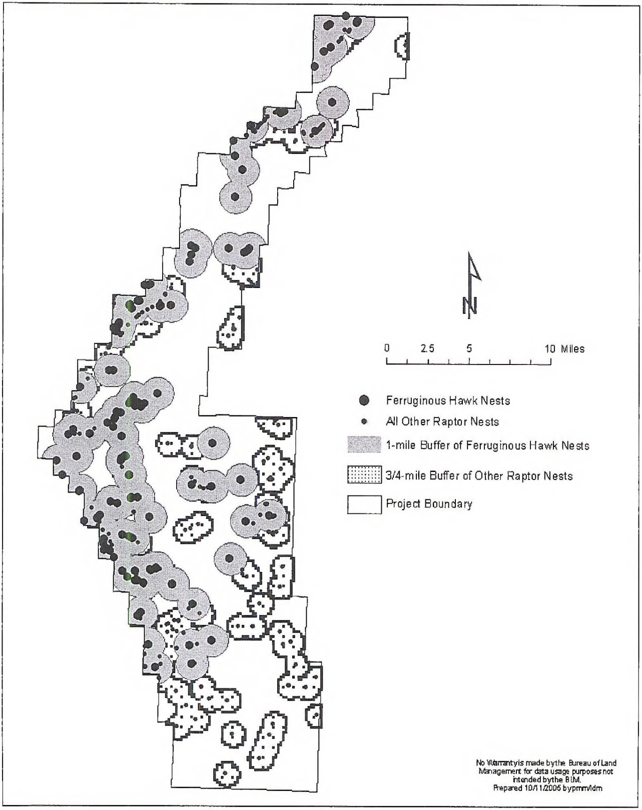
ATLANTIC RIM DRAFT EIS
Greater Sage-Grouse Leks



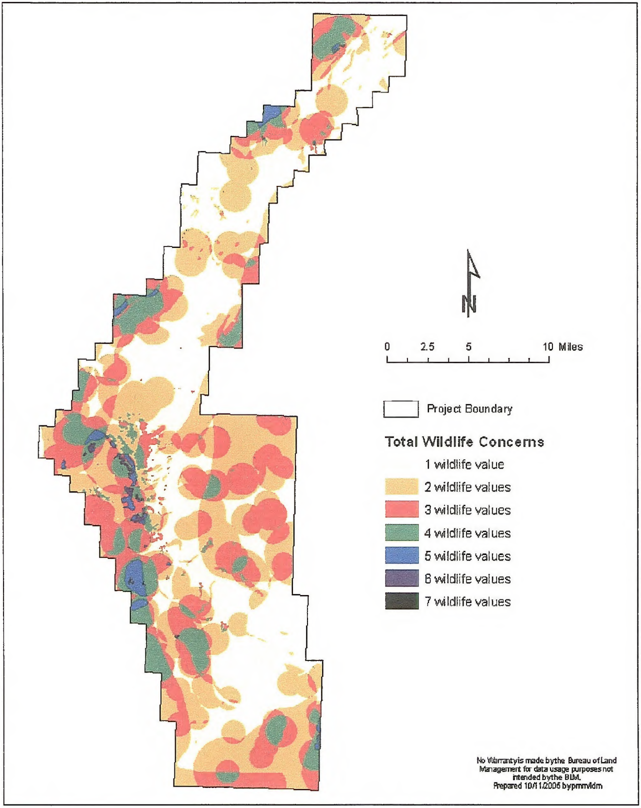
ATLANTIC RIM DRAFT EIS
Columbian Sharp-tailed Grouse Leks Nesting and Brood-Rearing Habitat



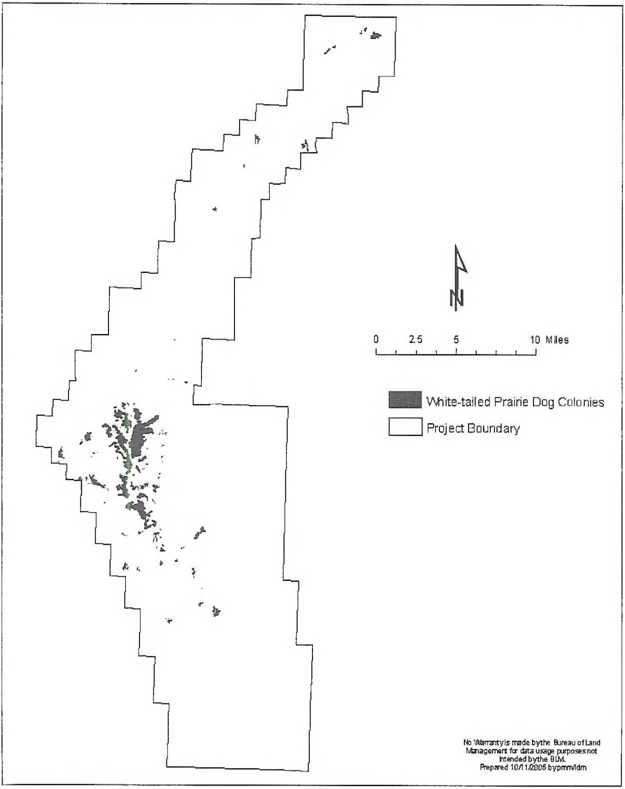
ATLANTIC RIM DRAFT EIS
Raptor Nest Locations

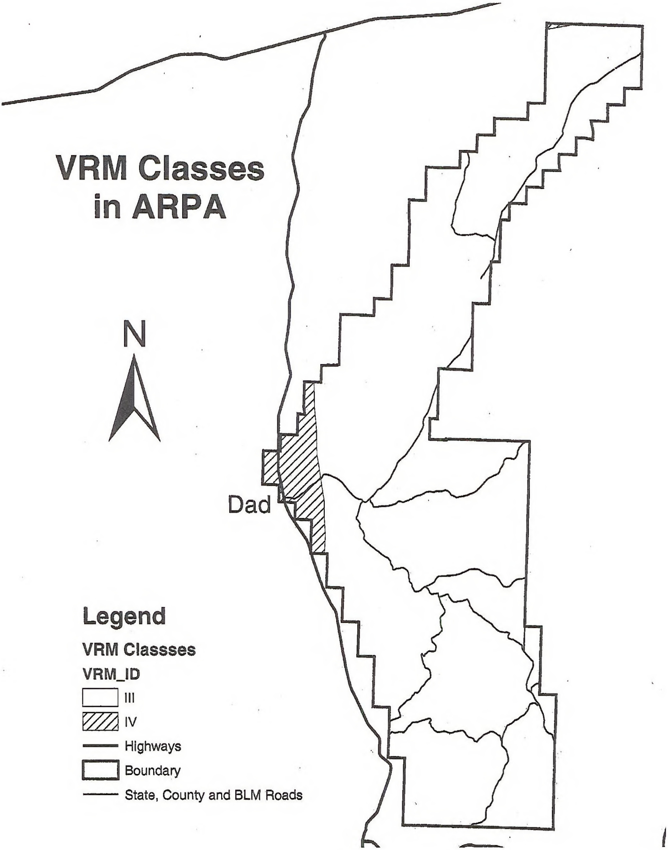


ATLANTIC RIM DRAFT EIS
Overlapping Wildlife Concerns

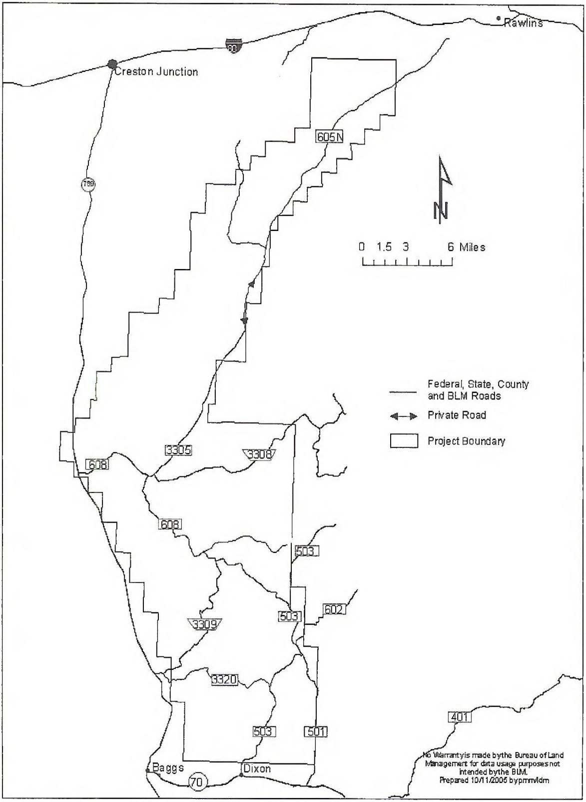


ATLANTIC RIM DRAFT EIS
White-Tailed Prairie Dog Colonies

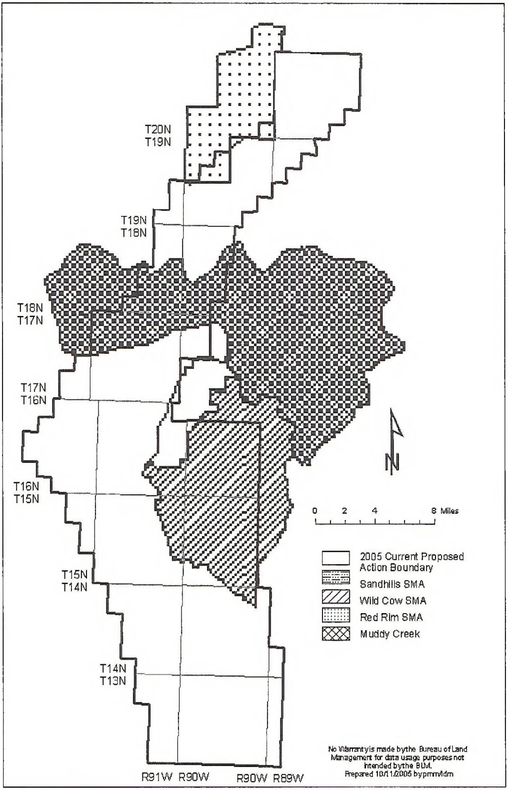



VRM Classes
in ARPA
N
Dad
Legend
VRM Classses
VRM_ID
III
IV
Highways
Boundary
State, County and BLM Roads

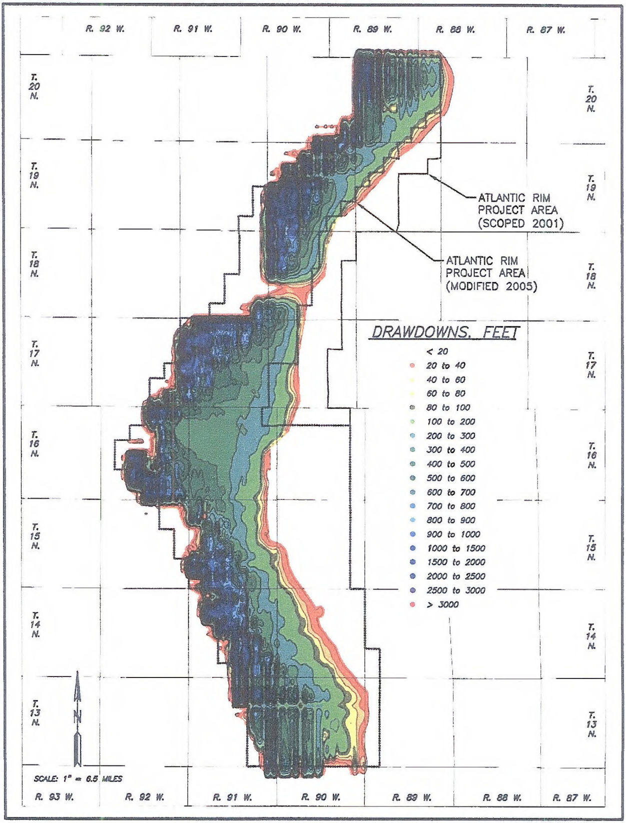
ATLANTIC RIM DRAFT EIS MAP
Federal, State, County, and BLM Roads



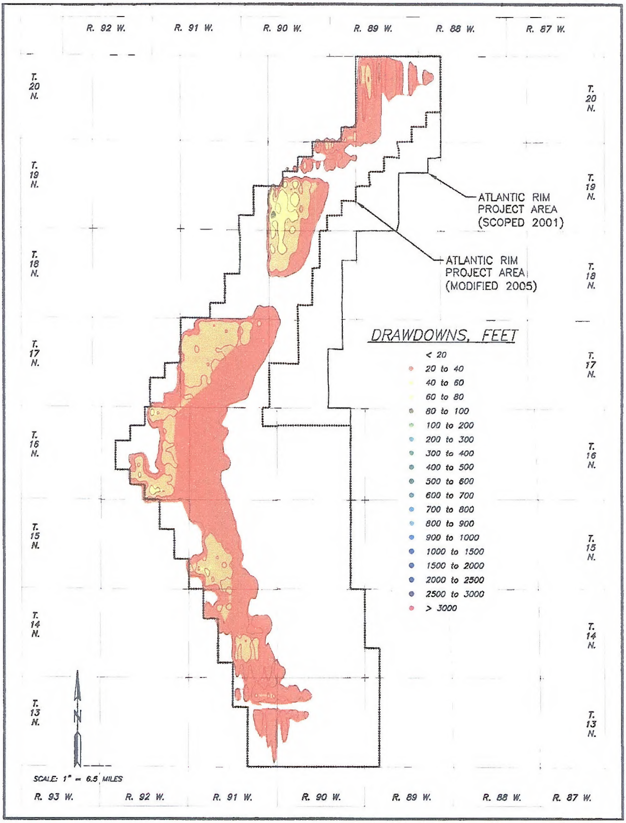
ATLANTIC RIM DRAFT EIS
Special Management Areas Overview



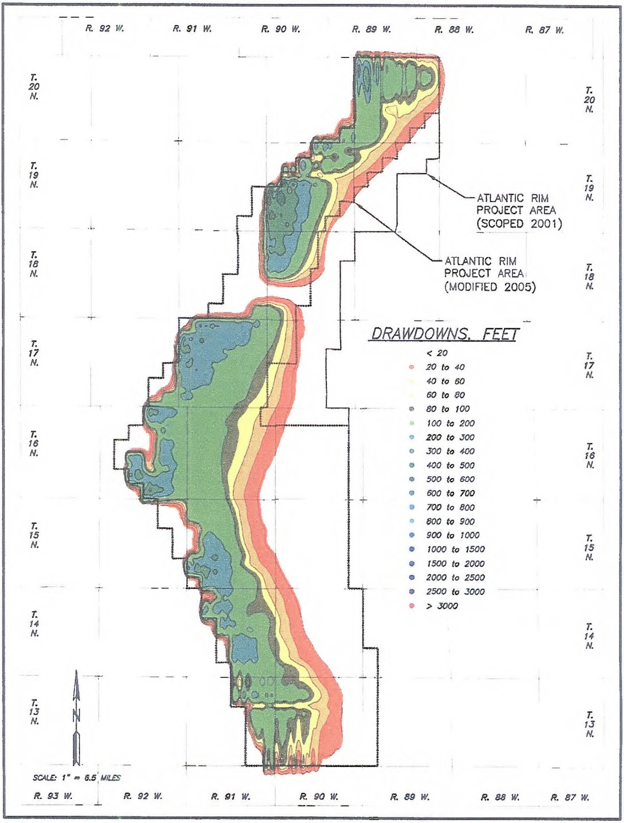
ATLANTIC RIM DRAFT EIS MAP
Drawdowns within Layer 3 for Year 2030



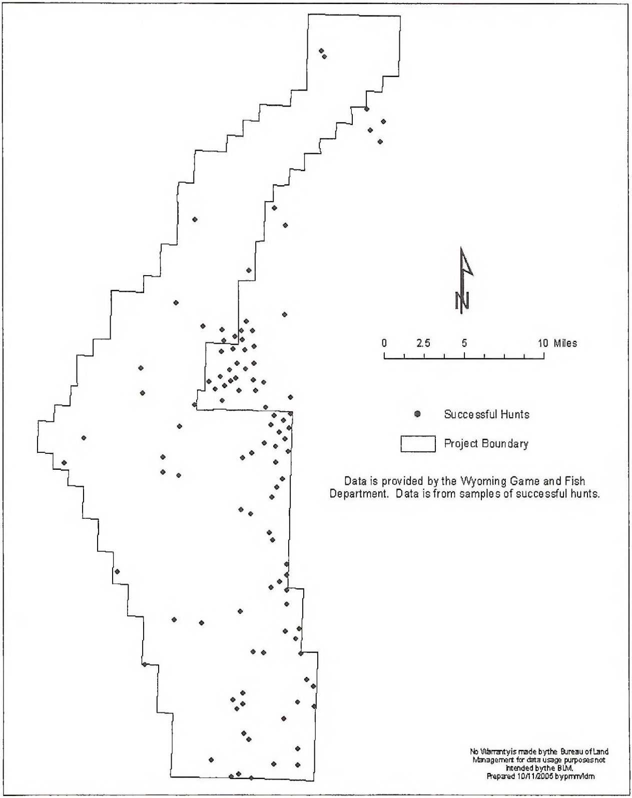
ATLANTIC RIM DRAFT EIS MAP
Drawdowns within Layer 1 for Year 2030



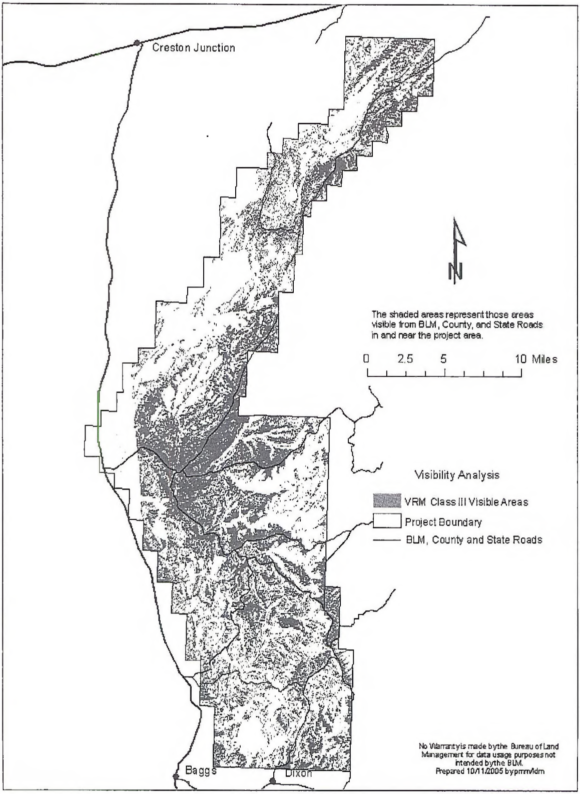
ATLANTIC RIM DRAFT EIS MAP
Drawdowns within Layer 5 for Year 2030



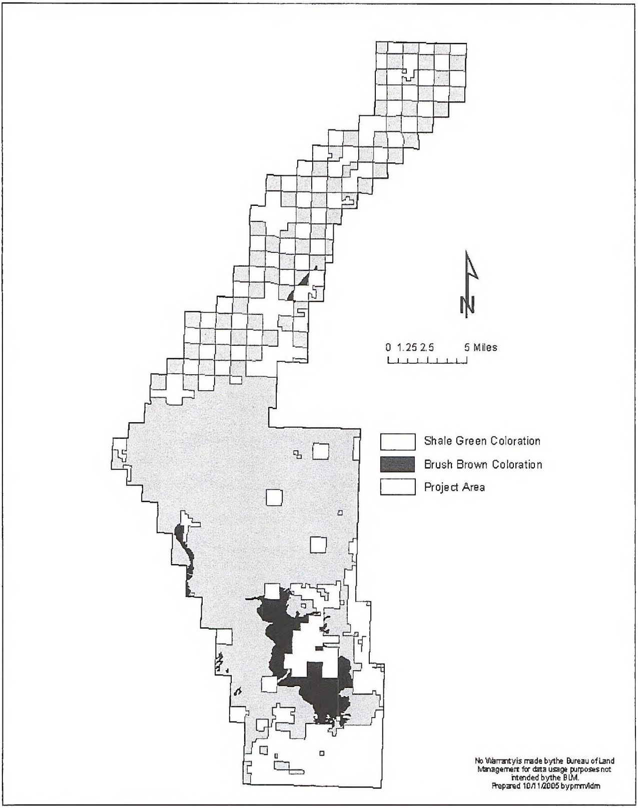
ATLANTIC RIM DRAFT EIS
Locations of Successful Hunts



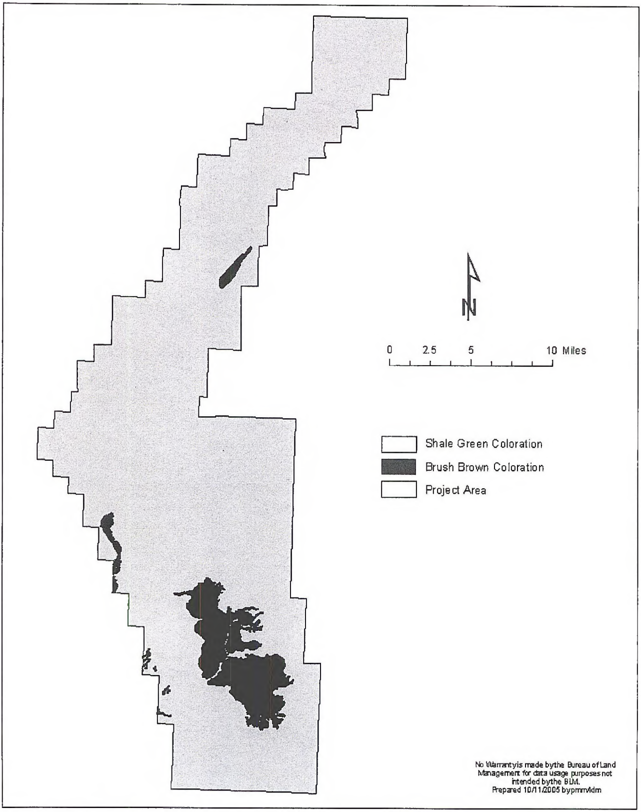
ATLANTIC RIM DRAFT EIS MAP
Areas Visible from Main Roads in VRM Class III with slopes <5%



ATLANTIC RIM DRAFT EIS
Project Area Facility Coloration for Federal Lands



ATLANTIC RIM DRAFT EIS
Project Area Facility Coloration



ATLANTIC RIM DRAFT EIS MAP
Far-field Modeling Domain and NEPA RFD Project Areas

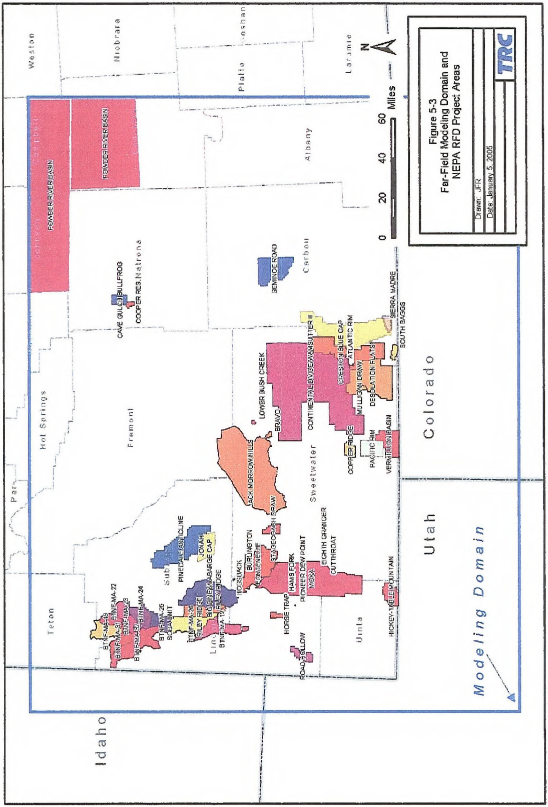
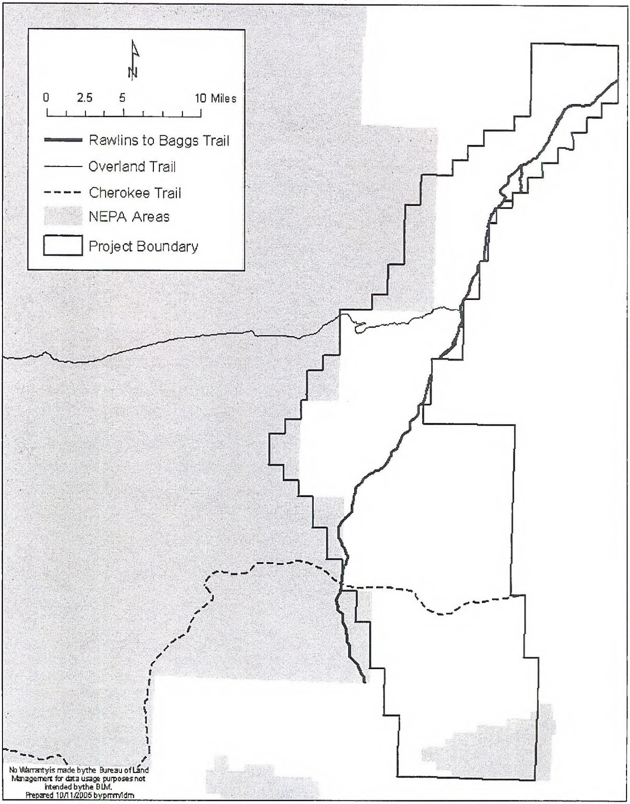
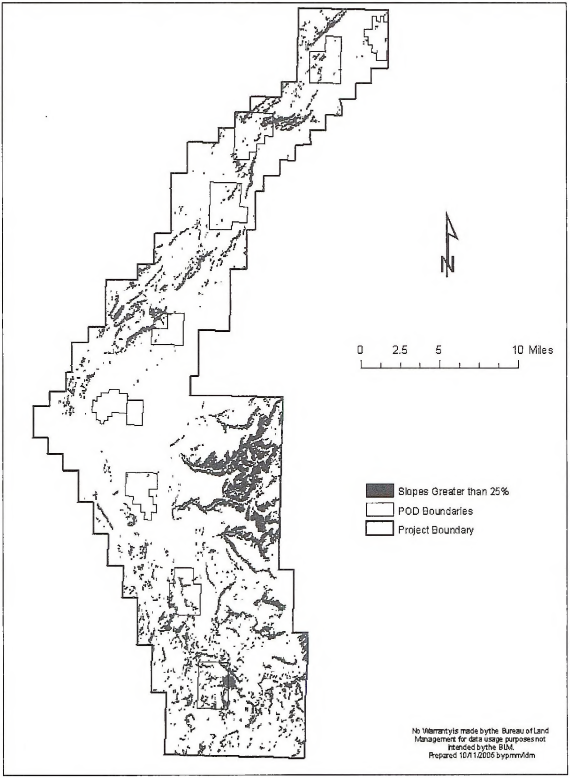


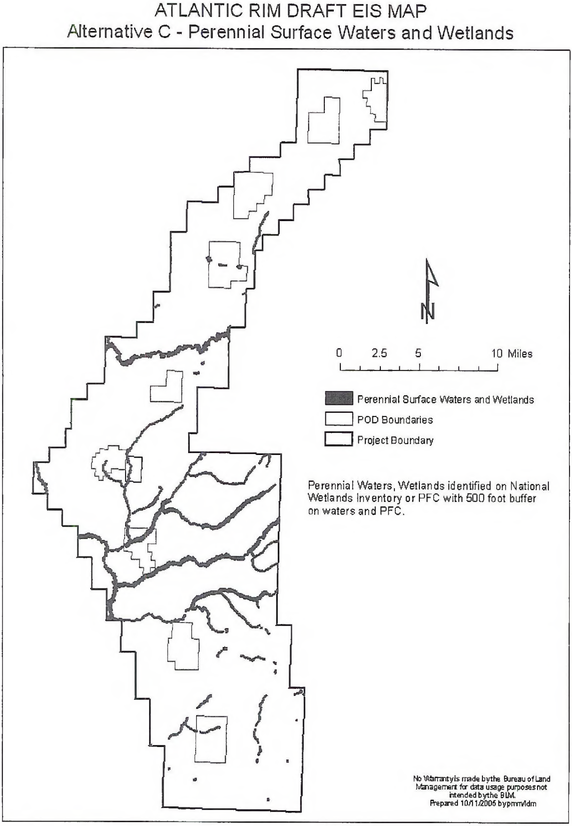
Figure 5-3
Far-Field Modeling Domain and NEPA RFD Project Areas

ATLANTIC RIM DRAFT EIS MAP
Chapter 5 - Cumulative Impacts Historic Trails

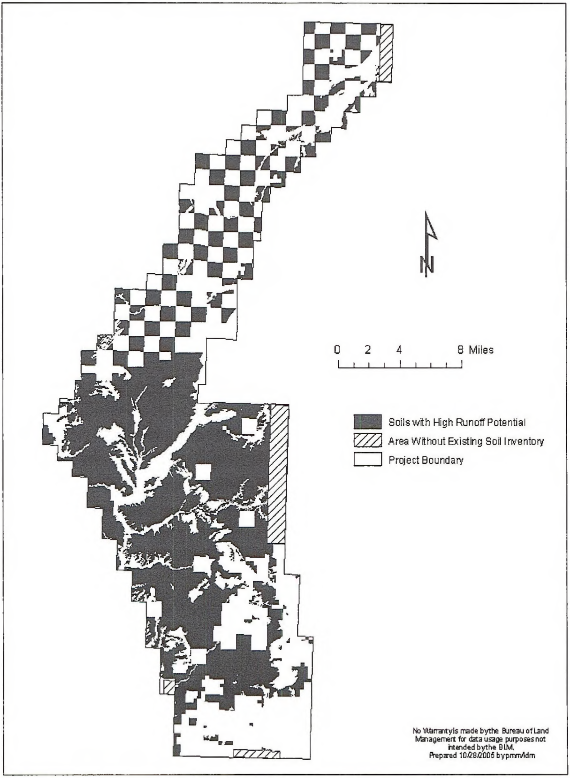


ATLANTIC RIM DRAFT EIS MAP
Alternative C - Slopes Greater than 25%

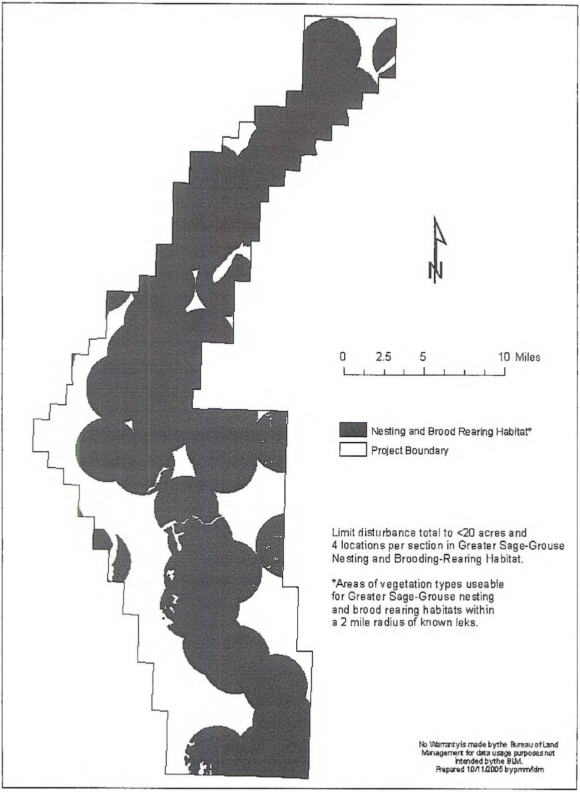



ATLANTIC RIM DRAFT EIS MAP
Alternative C - Perennial Surface Waters and Wetlands
N
0 2.5 5 10 Miles
Perennial Surface Waters and Wetlands
POD Boundaries
Project Boundary
Perennial Waters, Wetlands identified on National Wetlands Inventory or PFC with 500 foot buffer on waters and PFC.
No Warranty is made by the Bureau of Land Management for data usage purposes not intended by the BLM.
Prepared 10/11/2006 by pmm/dm

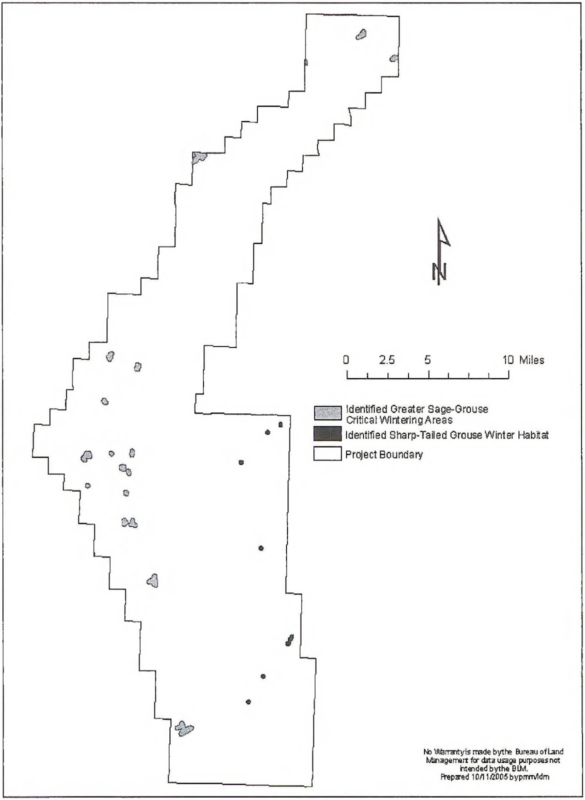
ATLANTIC RIM DRAFT EIS MAP
Alternative C - Soils with High Runoff Potential



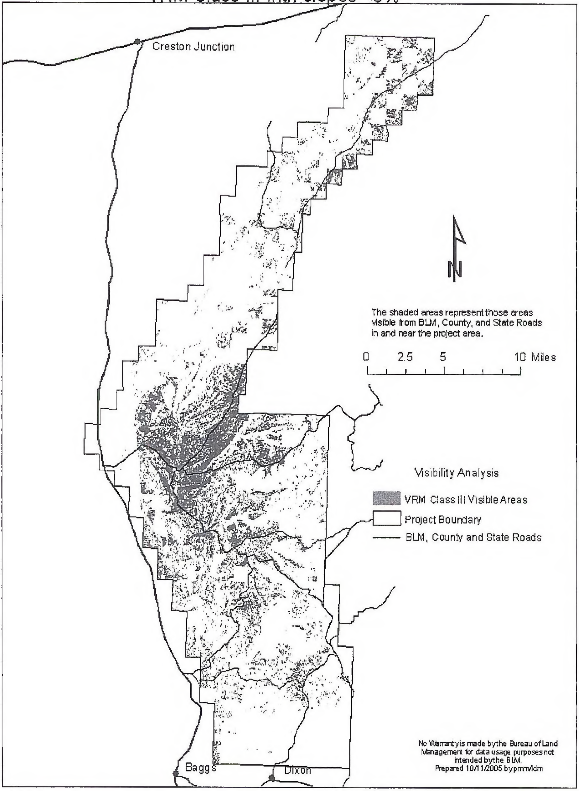
ATLANTIC RIM DRAFT EIS MAP
Alternative C - Greater Sage-Grouse Nesting and Brood-Rearing Habitat



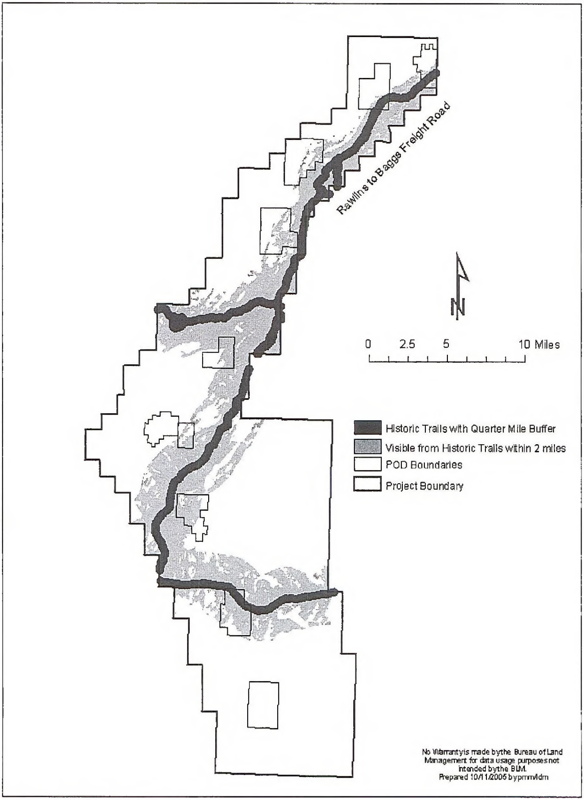
ATLANTIC RIM DRAFT EIS MAP
Alternative C - Grouse Critical Wintering Areas



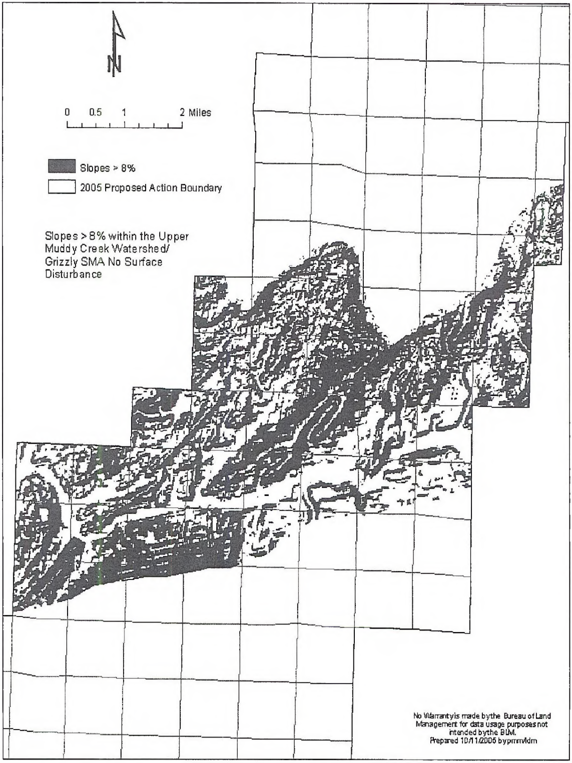
ATLANTIC RIM DRAFT EIS MAP
Alternative C - Areas Visible from Main Roads in VRM Class III with slopes <5%



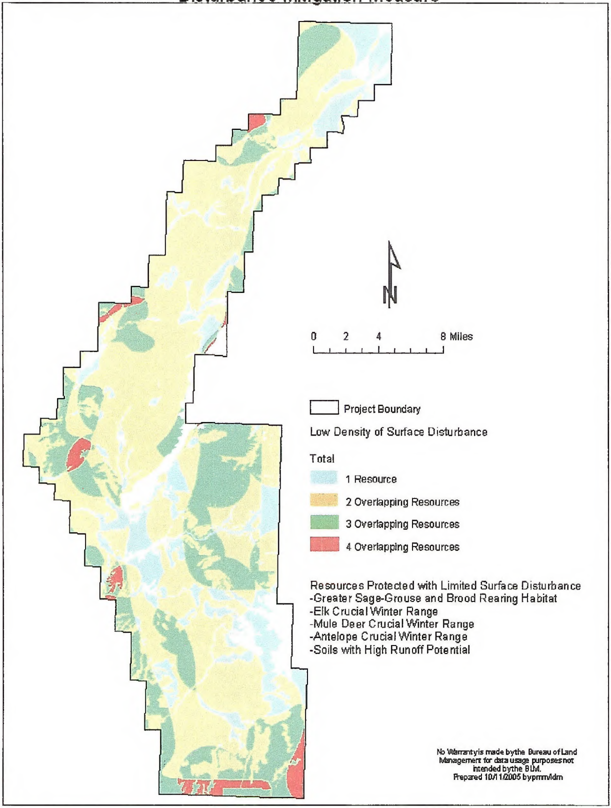
ATLANTIC RIM DRAFT EIS MAP
Alternative C - Historic Trails and 2 mile Visibility



ATLANTIC RIM DRAFT EIS MAP
Alternative C - Muddy Creek SMA
Slopes > 8%



ATLANTIC RIM DRAFT EIS MAP
Alternative C - Resources with Limited Surface Disturbance Mitigation Measure



ATLANTIC RIM DRAFT EIS MAP
Alternative C - Resources with Limited Surface Disturbance Mitigation Measure